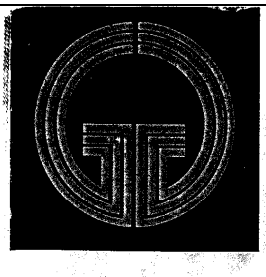

GMELIN

Handbook of Inorganic and Organometallic Chemistry

Complete Catalog 1997/98

Springer

Periodic Table of the Elements with the Gmelin System Numbers

1 **2** H																		2 **1** He
3 **20** Li	4 **26** Be											5 **13** B	6 **14** C	7 **4** N	8 **3** O	9 **5** F	10 **1** Ne
11 **21** Na	12 **27** Mg											13 **35** Al	14 **15** Si	15 **16** P	16 **9** S	17 **6** Cl	18 **1** Ar
19 * **22** K	20 **28** Ca	21 **39** Sc	22 **41** Ti	23 **48** V	24 **52** Cr	25 **56** Mn	26 **59** Fe	27 **58** Co	28 **57** Ni	29 **60** Cu	30 **32** Zn	31 **36** Ga	32 **45** Ge	33 **17** As	34 **10** Se	35 **7** Br	36 **1** Kr
37 **24** Rb	38 **29** Sr	39 **39** Y	40 **42** Zr	41 **49** Nb	42 **53** Mo	43 **69** Tc	44 **63** Ru	45 **64** Rh	46 **65** Pd	47 **61** Ag	48 **33** Cd	49 **37** In	50 **46** Sn	51 **18** Sb	52 **11** Te	53 **8** I	54 **1** Xe
55 **25** Cs	56 **30** Ba	57 ** **39** La	72 **43** Hf	73 **50** Ta	74 **54** W	75 **70** Re	76 **66** Os	77 **67** Ir	78 **68** Pt	79 **62** Au	80 **34** Hg	81 **38** Tl	82 **47** Pb	83 **19** Bi	84 **12** Po	85 **8a** At	86 **1** Rn
87 **25a** Fr	88 **31** Ra	89*** **40** Ac	104 **71**	105 **71**													

* **23** NH_4

Lanthanides **39	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
***Actinides	90 **44** Th	91 **51** Pa	92 **55** U	93 **71** Np	94 **71** Pu	95 **71** Am	96 **71** Cm	97 **71** Bk	98 **71** Cf	99 **71** Es	100 **71** Fm	101 **71** Md	102 **71** No	103 **71** Lr

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Recent Issues 1995/1997

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B	Boron Compounds, Fourth Supplement Volume lb
Be	Beryllium Supplement Volume B4
F	Perfluorohalogenoorgano Compounds of Main Group Elements Second Supple. V. 2
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Ga	Gallium Supplement Volume C2 Gallium Supplement Volume D2 Gallium Supplement Volume D3
Ge	Organogermanium 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
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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

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Be Beryllium Supplement Volume Dl (Coordination Compounds with Oxygen Containing Ligands)

F Perfluorohalogenoorgano Compounds of Main Group Elements, Second Supplement Volume 3 (Compounds with Nitrogen)

Ga Gallium Supplement Volume C1 & (Compounds with Hydrogen and Oxygen)

Ge Organogermanium Compounds Part 7 (Compounds with Germanium-Halogen Bonds continued)

Mo Organomolybdenum Compounds Part 1 (Mononuclear ^{1}L Mo Compounds)
Organomolybdenum Compounds Part 14 (Mononuclear ^{n}L Mo Compounds, n>6)

Ni Organonickel Compounds, First Supplement Part 4 (Mononuclear ^{2}L Ni Compounds)

Os Organoosmium Compounds Part B4b ($Os_3(CO)_nE$ Compounds)

P Phosphorus Supplement Volume C5b (Cyclic P-N Compounds)

Re Organorhenium Compounds Part 6 ($Re_2(CO)_{10}$ and $^{1}LRe_2$ Compounds)

S Sulfur Supplement Volume B5 (SO_2X_2 Compounds, X = Halogen)

Sc, Y. La-Lu Rare Earth Elements Volume C13b (Silicates)
Rare Earth Elements Volume C14a (Phosphides, P-O-Containing Compounds)
Rare Earth Elements Volume E2b (Spectra of Nd in Host Materials continued)

Si Silicon Supplement Volume B5b2 (Si_3N_4 Physical Properties)

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Sn Organotin Compounds Part 25 (Dinuclear Compounds)

Th Thorium Supplement Volume B1 (Thorium Metal)

U Uranium Supplement Volume B5 (Alloys with Platinum Group Metals)

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 perfluorohalogenoorgano compounds under F.

Reference Table

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 fur 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 exhaustive 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

System Numbers of the elements in the GMELIN Handbook:

System No.	Symbol	Element
1	He,Ne,Ar ...	Noble Gases
2	H	Hydrogen
3	O	Oxygen
4	N	Nitrogen
5	F	Fluorine
6	Cl	Chlorine
7	Br	Bromine
8	I	Iodine
8a	At	Astatine
9	S	Sulfur
10	Sc	Selenium
11	Tc	Tellurium
12	Po	Polonium
13	B	Boron
14	C	Carbon
15	Si	Silicon
16	P	Phosphorus
17	As	Arsenic
18	Sb	Antimony
19	Bi	Bismuth
20	Li	Lithium
21	Na	Sodium
22	K	Potassium
23	NH4	Ammonium
24	Rb	Rubidium
25	Cs	Caesium
25a	Fr	Francium
27	Mg	Magnesium
28	Ca	Calcium
29	Sr	Strontium
30	Ba	Barium
31	Ra	Radium
32	Zn	Zinc
33	Cd	Cadmium
34	Hg	Mercury
35	Al	Aluminium

System No.	Symbol	Element
36	Ga	Gallium
37	In	Indium
38	Th	Thallium
39	Sc,Y, La-Lu	Rare Earth Elements
40	Ac	Actinium
41	Ti	Titanium
42	Zr	Zirconium
43	Hf	Hafnium
44	Th	Thorium
45	Ge	Germanium
46	Sn	Tin
47	Pb	Lead
48	V	Vanadium
49	Nb	Niobium
50	Ta	Tantalum
51	Pa	Protactinium
52	Cr	Chromium
53	Mo	Molybdenum
54	W	Tungsten
55	U	Uranium
56	Mn	Manganese
57	Ni	Nickel
58	Co	Cobalt
59	Fe	Iron
60	Cu	Copper
61	Ag	Silver
62	Au	Gold
63	Ru	Ruthenium
64	Rh	Rhodium
65	Pd	Palladium
66	Os	Osmium
67	Ir	Iridium
68	Pt	Platinum
69	Tc	Technetium
70	Re	Rhenium
71	Np,Pu...	Transuranium Elements

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 the Last Position". This system, explained by the illustration above, makes it possible in principle to treat every compound once, and only once, and to collect those compounds characteristic of a given element under that element. The System Numbers of the elements in the Gmelin Handbook are not identical with the atomic numbers used in the Periodic Table. (See the Periodic Table as illustrated on the inside front cover, with the inserted colored System Numbers.)

Conventions for the volumes on Organometallic Chemistry

The organometallic volumes cover all compounds with metal-carbon bonds except carbides, cyanides, cyanates, and thiocyanates. 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 ^{1}L ligands comprise not only σ-bonded ligands (R) such as alkyl or aryl, but also CO, isocyanates, carbenes, carbynes, or η^2-bonded ligands coordinated by one C atom and one heteroatom. The higher ^{n}L ligands are exemplified by alkenes and alkynes (^{2}L), η^3-allyl groups (^{3}L), dienes (^{4}L), C_5H_5 (^{5}L), and arenes (^{6}L).

If necessary, ligands that are coordinated to the metal through heteroatoms (^{m}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 $P(CH_3)_3$ (^{2}D) and acetylacetonate (^{2}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://sdence.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 1980 onwards together with facts, structures, and reactions of more than 1,200,000 compounds.

Extensive search possibilities such as substructural search for coordination compounds, special ligand searches, treatment of multicomponent substances and systems, handling of alloys and ceramics enables the user easy access to this huge compilation of data.

GMELIN
Handbook of Inorganic and Organometallic Chemistry
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Varrentrappstrafie 40/42 (Carl-Bosch-Haus) D-60486 Frankfurt (Main) Federal Republic of Germany

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 I: **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 fro 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 data: 1993.
1994. XIII, 416. Cloth ISBN 3-540-93685-8

Actinium - Ac

Main Volume

Includes history, occurrence, formation of the element by radioactive decay, and the making of actinium preparations. Physical properties, electrochemical behavior, and chemical reactions of actinium solutions, as well as detection and determination, are covered. Actinium compounds are reviewed briefly. Mesothorium 2 (= ^{228}Ac) is also described. -
Literature closing date: end of 1939.
1942, reprint 1969. 1 fig. XI, 82 pages (in German).
Cloth ISBN 3-540-93001-9

Supplement Volume l

The element, ions, isotopes, compounds, and reactions. Extraction and ion exchange, for preparation and analysis. History of discovery of actinium and its occurrence in nature. Biological properties; handling and safety precautions. The nuclide ^{227}Ac finds practical application in thermionic radioisotope batteries. - Literature closing date: mid-1980.
1981. 155 figs. XVI, 316 pages.
Cloth ISBN 3-540-93445-6

Silver - Ag

Main Volume

Part A: **History. Occurrence. The Element**

Section 1: **History. Occurrence**

History. Cosmochemistry. Geochemistry: crystallochemical fundamentals, geochemical character and abundance, silver in the lithosphere, hydrosphere, and atmosphere. Minerals. A chapter on production statistics and the most important deposits completes this volume. -
Literature closing date: end of 1968.
1970. XI, 144 pages (in German). Cloth
ISBN 3-540-93202-X

Section 2: The **Element (Technology and Preparation. Isotopes. The Atom. Molecules. Physical Properties of the Metal)**

Preparation by pyrometallurgical and wet metallurgical methods, by the amalgam process, recovery of crude silver from anode muds, purification, and secondary recovery. Preparation, separation, enrichment, and properties of the isotopes. -
Literature closing date: 1968. 1970. 76 figs. XXII, 350 pages (in German). Cloth
ISBN 3-540-93203-8

Section 3: **The Element (Chemical Reactions. Detection and Determination. Toxicity. Colloidal Silver)**

Chemical reactions of the metal and of the Ag^{I} and Ag^{II} ions. Detection and determination, including detection and determination of the isotopes. Also discusses colloidal silver. -
Literature closing date: end of 1969. 1971. 14 figs. XVIII, 224 pages (in German). Cloth
ISBN 3-540-93204-6

Section 4: **The Element (Electrochemical Behavior)**

Chapters on standard potential, ionic mobility, Ag | silver salt electrodes, polarography, and electrode reactions complete the four-volume treatment of elemental silver. -
Literature closing date: end of 1969.
1973. 132 figs. XX, 394 pages (in German). Cloth
ISBN 3-540-93205-4

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 bromooxoacids. 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). Cloth
ISBN 3-540-93207-0

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

The virtually insoluble black chalcogenides Ag_2S, Ag_2Se, and Ag_2Te - which occur in many modifications - are emphasized. The sulfate, thiosulfate, carbonate, cyanide, and thiocyanate are also covered. - Literature closing date: end of 1971. 1973. 149 figs. XXVIII, 389 pages (in German). Cloth
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). Cloth
ISBN 3-540-93209-7

Section 5: **Organosilver Compounds. Organosilver Salts**

Covers the organosilver compounds. Subsections deal with σ-compounds (especially the alkyl and alkynyl 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). Cloth
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_2O, NH_3, N_2H_4, and NH_2OH) are covered first, followed by organic ligands (amines, N-heterocycles, alcohols, aldehydes, ketones, ethers, O-heterocycles, aminoalcohols, aminoacids, 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(I) Complexes with Ligands which Contain S, Se, Te, P, As, Sb, Bi, B, Si, or Ge; Silver(II) and Silver(III) Complexes. Subject and Ligand Index for Silver Part B Sections** l **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). Cloth
ISBN 3-540-93310-7

Part C: **Alloys**

Alloys of silver up to the Ag-Cu system and related multicomponent alloys. Silver alloys for the following uses: jewelry and tableware, electrical contacts, instrument construction, solders and brazing alloys, bearings, dentistry, electrodes for commercial electrochemical processes, coinage, and catalysts. - Literature closing date: mid-1970.
1972. 219 figs. XXXII, 501 pages (in German). Cloth
ISBN 3-540-93210-0

Aluminium - Al

Main Volume

Part A: **History. Occurrence. The Element. The Alloys**

Division I

Section 1: **History. Occurrence. Preparation. Allotropic Modifications. Structure. Recrystallization. Physical Properties**

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**

Non-metallic protective films, especially oxide layers, and metallic coatings are covered. - Literature closing date: August 1935.
1935, reprint 1966. 23 figs. X, 84 pages (in German).
Cloth ISBN 3-540-93004-3

Division II

Section 4: **Aluminium Alloys with Silicon up to Radium**

Aluminium alloys with silicon, phosphorus, arsenic, antimony, bismuth, alkali metals, and alkaline earth metals, including radium. - Literature closing date: January 1936.
1936, reprint 1968. 92 figs. XI, 148 pages (in German).
Cloth ISBN 3-540-93005-1

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 Rhenium**

Aluminium alloys with manganese, nickel, cobalt, silver, gold, the platinum metals, and rhenium. 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**

Covers alloys with iron and carbon - and thus includes the aluminium steels and the aluminium-containing cast irons. The final chapter covers the aluminium-iron-silicon alloys. -
Literature closing date: December 1948.
1950, reprint 1973. 78 figs. X, 136 pages (in German).
Cloth ISBN 3-540-93257-7

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

History, occurrence, and uses. A discussion of the element covers formation, preparation, physical properties, electrochemical behavior, chemical reactions, and physiological activity. Compounds with hydrogen up to phosphorus. -
Literature closing date: end of 1949.
1952, reprint 1971. 20 figs. XXXVII, 475 pages (in German).
Cloth ISBN 3-540-93019-1

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**

Occurrence covers cosmochemistry, geochemistry, deposits, and minerals. The discussion of manufacture includes ore dressing, recovery of gold both from nature and from industrial products, and gold refining. -
Literature closing date: end of 1949.
1954, reprint 1974. 20 figs. XVI, 306 pages (in German).
Cloth ISBN 3-540-93265-8

Section 3: **Physical Properties. Electrochemical Behavior and Chemical Reactions. Detection and Determination. Gold Compounds. Gold Alloys**

Has a general section on the reactions of gold salts. Compounds and alloys include all elements except the platinum-group elements, Tc, 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, $AuCl_2^-$, $AUCl_3$, and above all $AuCl_4^-$. 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, NH_4, Rb, or Cs. Concludes with the description of compounds composed of an inorganic aurate anion and an onium (ammonium, iminium, iodonium, sufonium, carbenium, phosphonium, arsonium) cation. - Literature closing date: end of 1993. 1995. 95 figs. XXII, 400 pages. Cloth
ISBN 3-540-93719-6

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

Boron - B

Main Volume

History, occurrence, preparation of the element, its physical properties, and its chemical reactions. Boranes, oxides, acids, nitrides, halides, and compounds with selenium are also covered. - Literature closing date: end of 1925.
1926, reprint 1970. 11 figs. XVII, 142 pages (in German).
Cloth ISBN 3-540-93033-7

Supplement Volume 1

Additional data on occurrence. Covers the beginnings of the newer chemistry of boron, especially in those sections dealing with boron compounds. A chapter on boron-carbon compounds is included covering compounds such as boron carbide, boron alkyls, complexes of boric acid with polyalcohols (e.g., mannitol), and alkyl-boron-nitrogen compounds. -
Literature closing date: end of 1949.
1954, reprint 1976. 28 figs. XX, 253 pages (in German).
Cloth ISBN 3-540-93034-5

Supplement Volume 2: **Elemental Boron. Boron Carbides**

Preparation, structures, and properties of the numerous modifications of elemental boron. The B-C system, boron carbides, and the production and uses of "B_4C". - Literature closing date: mid-1980 for elemental B and the end of 1975 for systems and compounds with carbon. 1981. 89 figs. XVI, 242 pages. Cloth
ISBN 3-540-93448-0

Boron Compounds

Part 1: **Binary Boron-Nitrogen Compounds, B-N-C-Heterocycles. Polymeric Boron-Nitrogen Compounds** (New Suppl. Ser. Vol. 13)

Includes BN, $(Bi_2)4B_2N_x$, 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 2: Carboranes 1 (New Suppl. Ser. Vol. 15) Covers nomenclature and types of compounds, small and intermediate size nido-carboranes, arachno-carboranes, small and intermediate size closo-carboranes, ionic carboranes with one or two skeletal C atoms, and NMR spectra of the preceding compounds. -
Literature closing date: Chapter 1, 1973; Chapters 2 through 8, 1970. 1974. 183 figs. XVIII, 288 pages (in German).
ISBN 3-540-93277-1

Part 3: **Compounds of Boron with the Nonmetals S, Se, Te, P, As, Sb, and Si, and with Metals** (New Suppl. Ser. Vol. 19)

The arrangement here deviates from the framework of the Gmelin "System of the Last Position", so as to round out the total presentation of the element boron. Thus, species containing boron-metal bonds (except for borates but including derivatives of the higher boron hydrides) are discussed. -
Literature closing date: end of 1973.
1975. 9 figs. XX, 201 pages (135 pages in German).
Cloth ISBN 3-540-93285-2

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

Tris-, bis-, and monoaminoboranes, iminoboranes, imidoboranes, hydrazino- and azidoboranes, B-N ring compounds, especially the borazines, and B-N ring compounds with further heteroatoms. - Literature closing date: end of 1973.
1975. 13 figs. XX, 360 pages (329 pages in German).
Cloth ISBN 3-540-93289-5

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 figs. 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 figs. 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 figs. 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, organyloxo, 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-carboxylate 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 figs. 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 figs. 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), tetrahaloborate ions $[BX4]^-$ where X = halogen or pseudohalogen, carbonyl boranes, and noble gas adducts of boron compounds. -
Literature closing date: end of 1975.
1976. 11 figs. 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-anions, and most of their carbon-substituted derivatives. - Literature closing date: end of 1975. 1977. 6 figs. XIV, 207 pages (in German). Cloth
ISBN 3-540-93336-0

Part 12: **Carboranes 4** (New Suppl. Ser. Vol. 43) Completes the treatment of dicarba-closo-dodecaboranes and their derivatives and covers the remaining carbon-substituted derivatives of dicarba-closo-dodecaboranes, the boron-substituted species, and tetracarba-closo-dodecaboranes(12). The ^{11}B, ^{1}H, and ^{13}C NMR spectra for the three isomeric dodecaboranes and their derivatives are compiled in a final comprehensive table. - Literature closing date: end of 1975. 1977. 5 figs. XIV, 306 pages (in German). Cloth
ISBN 3-540-93337-9

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

Continuation of "Boron Compounds" Part 7. Treats the borate-polyol complexes existing in solution, tris(organyloxy)boranes $B(OR)_3$, cyclo-trioxa-diborane H2B3O3, and boroxins (-BR-O-)$_3$. Literature closing date: end of 1975. 1977. 33 figs. XVI, 239 pages (in German). Cloth
ISBN 3-540-93339-5

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. (BH_3 and BH3 are treated with B2H6 in "Boron Compounds" Part 18.) Also covered are amineboranes, (organyl)hydrodiboranes(6), (organyl)-hydroboranes(3), and (halo)-hydropolyboranes. -
Literature closing date: end of 1975.
1977. 32 figs. 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)

Covers the amine adducts of dihydroboranes, of monohydroboranes, and of trihalo- and tripseudohaloboranes. -
Literature closing date: end of 1975.
1977. 2 figs. XX, 170 pages (81 pages in German).
Cloth ISBN 3-540-93347-6

Part 16: **Boron-Oxygen Compounds** 2 (New Suppl. Ser. Vol. 48)

Topics are peroxyboranes, species containing HBO and CBO moieties, etc. - Literature closing date: end of 1975.
1977. 8 figs. XVIII, 221 pages (37 pages in German).
Cloth ISBN 3-540-93353-0

Part 17: **Borazine and Its Derivatives** (New Suppl. Ser. Vol. 51) Borazine, symmetrically and unsymmetrically substituted borazine, oligo- and polyborazines. Not included are spectroscopy of borazines, which is in "Boron Compounds" Part 5, and polymeric compounds, which are in "Boron Compounds" Part 1. - Literature closing date: end of 1976. 1978. 10 figs. XVIII, 248 pages (in German). Cloth
ISBN 3-540-93360-3

Part 18: **Boron-Hydrogen Compounds 2**
(New Suppl. Ser. Vol. 52)

The boron-hydrogen compounds, including BH_3, B_2H_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.CO. - Literature closing date: end of 1976.
1978. 40 figs. XVIII, 238 pages (152 pages in German).
Cloth ISBN 3-540-93372-7

Part 19: **Boron-Halogen Compounds 2** (New Suppl. Ser. Vol. 53)

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

Part 20: **Boron-Hydrogen Compounds 3**
(New Suppl. Ser. Vol. 54)

Boron hydrides containing five to forty-eight boron atoms and their derivatives are the topics of this last of twenty volumes on boron compounds. - Literature closing date: end of 1977 for the hydrides, end of 1976 for the derivatives. 1979. 113 figs. XVIII, 305 pages. Cloth

ISBN 3-540-93390-5

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.
1979. IX, 397 pages. Cloth ISBN 3-540-93399-9

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).
ISBN 3-540-93417-0

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

Contains the boron-chalcogen compounds and the carboranes, 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**

Describes boranes, boron oxides, borate ions, and boric acids. Borate minerals. The section on boron-nitrogen compounds treats boron nitride, aminoboranes, borazine, ammine-boranes, and numerous heterocyclic B-N and B-N-O compounds. An alphanumeric formula index is included. - Literature closing date: 1980. 1983. 127 figs. XVI, 508 pages. Cloth
ISBN 3-540-93466-9

Volume 2: **Boron and Halogens, Chalogens, 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. 1987. 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 boric 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_2BCl) and followed by the related organoboranes ($RBCl_2$, R_2BCl), and those with O or N (e.g., $Cl_2BN(CH_3)_2$). 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.
1988. XI, 241 pages. Cloth ISBN 3-540-93576-2

Boron Compounds, Fourth Supplement

Volume la: 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 lb**: 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 figs. 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 figs. 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, pyrazaboles, 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 figs. XV, 254 pages. Cloth

ISBN 3-540-93648-3

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

Emphasis is on BCl_3 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 figs. XX, 323 pages. Cloth

ISBN 3-540-93629-7

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 ^{10}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 figs. XVI, 900 pages (in German).
Cloth ISBN 3-540-93411-1

Barium - Ba

Main Volume

History, occurrence, and recovery of barium compounds from raw materials. Describes the formation and preparation of the metal, its physical properties, electrochemical behavior, and chemical reactions. Compounds and systems from barium and hydrogen to barium and strontium are covered. - Literature closing date: March 1932.
1932, reprint 1972. 31 figs. XXXVII, 390 pages (in German).
Cloth ISBN 3-540-93020-5

Supplement Volume

The same arrangement is used here as in the Main Volume. Alloys with antimony, bismuth, calcium, and strontium are covered. A special chapter is devoted to the manufacture and properties of barium oxide cathodes. - Literature closing date: end of 1949. 1960. 76 figs. LI, 569 pages (in German). Cloth

ISBN 3-540-93021-3

Beryllium - Be

Main Volume

Main Volume

Compounds covered are those of beryllium and H, alkali metals, NH4, B, C, Si, nitrogen-group elements, chalcogens, halogens, and noble gases. - Literature closing date: April 1930.
1930, reprint 1970. 10 figs. XXIII, 180 pages (in German).
Cloth ISBN 3-540-93022-1

Supplement Volume

Part A: **The Element**

Section 1: **The Element. Production, Atom, Molecules, Chemical Behavior, Toxicology**

Deals with the production of beryllium, its uses, the nuclides, atoms and ions, molecules, chemical reactions, the chemical behavior of Be^{2+} in solution (limited to hydration, hydrolysis, and a short survey of the analytically most important precipitation reactions), toxicology of beryllium. - Literature closing date: 1985. 1986. 68 figs. XVI, 317 pages. Cloth

ISBN 3-540-93534-7

Section 2: **The Element. Physical Properties**

Describes the properties of the bulk metal with emphasis on the crystallographic structure and structure-related mechanical properties. Includes thermal and magnetic properties. - Literature closing date: 1990. 1991. 63 figs. XIV, 276 pages. Cloth

ISBN 3-540-93626-2

Section 3: **The Element. Physical Properties** (Continued) **and Electrochemical Behavior**

Continues the description of the bulk metal with emphasis on the electrical, electronic, and optical properties. Includes electron emission and impact phenomena. The electrochemical behavior of the element (standard potentials, behavior as cathode or anode, polarography, voltammetry, electrodeposition) is treated in detail. - Literature closing date: 1992. 1993. 68 figs. XVI, 277 pages.

ISBN 3-540-93674-2

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 NH_4, 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

1SBN 3-540-93556-8

Bismuth - Bi

Main Volume

Covers the element and its compounds with H, B, C, Si, N, P, As, Sb, chalcogens, and halogens. A special chapter deals with the Bi radioactive isotopes (radium C, thorium C, actinium C, and radium E) known from decay series. -
Literature closing date: July 1926.
1927, reprint 1971. 11 figs. XXIV, 229 pages (in German). Cloth

ISBN 3-540-93237-2

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

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.
1931, reprint 1965. 9 figs. XXII, 342 pages (in German). Cloth

ISBN 3-540-93035-3

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 Br_2 in the gas phase, the system bromine-water, and the electrochemistry. The various ions of bromine are important, e.g., Br_2^+, Br_2^-, and especially Br_3^-. - 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 1990.
1992. 8 figs. XVI, 267 pages. Cloth

ISBN 3-540-93638-6

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 BrF_3 and BrF_5 as well as on BrF, BrCl, and $BrCl_2^-$.- Literature closing date: end of 1990. 1991. 9 figs. XVI, 245 pages. Cloth

ISBN 3-540-93642-4

Carbon - C

Main Volume

Part B: **The Element**

Section 1: Isotopes. Atom. Molecules. Single Component System. Vapor. Diamond

Begins with a discussion of the properties and the enrichment and separation of the stable and unstable isotopes of carbon. Other chapters cover atoms and atomic ions, C_2, C_3, C_4, and C_4, the phase diagram, sublimation, fusion, solid phase transformations, carbon vapor, and the carbon arc. The volume concludes with chapters on diamond and its properties. - Literature closing date: end of 1963. 1967. 131 figs. XX, 352 pages (in German). Cloth

ISBN 3-540-93101-5

Section 2: **Graphite**

The major chapters cover technology, physical properties, surface phenomena (including adsorption), and electrochemical behavior. - Literature closing date: end of 1965. 1968. 175 figs. XXI, 436 pages (in German). Cloth

ISBN 3-540-93102-3

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 (Cl^-, Br^-, ICl^-, and IBr^- graphites, nitrate, sulfate, and alkali 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_X and C_2H_X molecules, radicals, and ions, and also of benzene and toluene. Has short sections on C_2O and C_3O_2; larger sections are devoted to CO and CO_2 and include, in each case, systems of the compounds with inorganic and organic components. - Literature closing date: 1968.
1970. 123 figs. XXXIV, 584 pages (in German).
ISBN 3-540-93104-X

Section 2: **Chemical Reactions of CO and CO2**

Covers the several equilibria among C, O_2, CO, and CO_2, as well as the chemical reactions of CO and CO_2. - Literature closing date: 1971.
1972. 20 figs. XX, 208 pages (in German). Cloth
ISBN 3-540-93105-8

Section 3: **The CO_2 + C ↔ 2 CO Equilibrium. Aqueous Solutions of Carbonic Acid. Carbonate Ions. Peroxocarbonic Acids**

Begins with coverage of the CO_2 + C ↔2 CO equilibrium. The major portion of this volume is then devoted to the dissolution of CO2 in water and in aqueous solutions, and to the properties of such systems. - Literature closing date: 1972.
1973. 22 figs. XVI, 160 pages (in German). Cloth
ISBN 3-540-93106-6

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_3O and CH_2O^-, HCO and HCO^+, CHO_2 and CO_2^-, $HOCO_2$ and CO_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 - all from the viewpoint of inorganic chemistry. - Literature closing date: end of 1970.
1971. 51 figs. XXX, 475 pages (in German). Cloth
ISBN 3-540-93107-4

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_2, CXY, CHX; CX_3, CX_2Y, CXYZ, CHX_2, CHXY, CH_2X; CX4, CX_3Y, CX_2Y_2, CX_2YZ. The radicals CX, CX_2, etc., are emphasized, as are the CX_4 molecules. - Literature closing date: end of 1972. 1974. 51 figs. XXIV, 386 pages (in German). Cloth
ISBN 3-540-93108-2

Section 3: **Carbon-Halogen Compounds** (Continued)

Continues the treatment of simple carbon-halogen compounds. Included are the following: XCO radicals and ions, phosgene $COCl_2$ and the other carbonyl halides COX_2, halogen derivatives of urea, carbamic acid halides, halogen isocyanates, halogen cyanides XCN, halogen isocyanides XNC, cyanuric acid halides, the F_2CN radical, and halogenated cyanamides. - Literature closing date: mid-1974. 1976. 13 figs. XXXVI, 294 pages (in German). Cloth
ISBN 3-540-93309-3

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 $C S_2$, CS and its ions, and ions of CS_2. - Literature closing date: beginning of 1975.
1977. 19 figs. XXVI, 271 pages (in German). Cloth
ISBN 3-540-93330-1

Section 5: **Carbon-Sulfur Compounds** (Continued)

Continues the discussion of compounds of carbon and sulfur. The emphasis is on C_3OS, COS and its ions, and the several NCS and CNS ions, including $(SCN)_2$, and $(SCN)_3$. Further compounds covered are ArOCS, $S_X(CN)_2$ with x = 1 to 8, and (NC) (NCS). - Literature closing date: 1975. 1977. 16 figs. XXIV, 237 pages (in German). Cloth
ISBN 3-540-93342-5

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 $(NH_2)_2CS$, and thiocarbonyl halides X_2CS and XYCS, where X or Y is halogen. It also covers the noncyclic carbon compounds of selenium and tellurium. - Literature closing date: end of 1975. 1978. 24 figs. XXXII, 264 pages (in German). Cloth
ISBN 3-540-93356-5

Perfluorohalogenoorgano Compounds of Main Group Elements

See "F" Fluorine

Calcium - Ca

Main Volume

Part A: **History. Occurrence. The Element. The Alloys**

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.
1950, reprint 1967. VI, 68 pages (in German). Cloth
ISBN 3-540-93039-6

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. Alloys of calcium with antimony, bismuth, lithium, sodium, potassium, and beryllium are covered. - Literature closing date: end of 1949.
1957, reprint 1974. 29 figs. XXX, 420 pages (in German). Cloth
ISBN 3-540-93259-3

Part B: **Technology. Compounds**

Section 1: **Technology**

The first chapter is devoted to raw materials (fluoride, sulfate, carbonate, and phosphates). Other chapters cover the technology of metallic calcium, of simple compounds, and of calcium salts of organic carboxylic acids. A special chapter deals with the manufacture of phosphate fertilizers. - Literature closing date: end of 1949.
1956, reprint 1971. 28 figs. XXII, 264 pages (in German).
Cloth ISBN 3-540-93040-X

Section 2: **Calcium Compounds up to Dithionite**

Covers calcium compounds with hydrogen, oxygen, nitrogen, halogens, and sulfur up to and including calcium dithionite. - Literature closing date: end of 1949.
1957, reprint 1971. 46 figs. XXXVII, 392 pages (in German).
Cloth ISBN 3-540-93041-8

Section 3: **Calcium Compounds** (Continued). **Chemical Reactions of Calcium Ion. Detection and Determination of Calcium, Strontium, and Barium**

Completes the coverage of the calcium compounds. Specifically, calcium compounds with sulfur (starting with the Ca-S-O system), selenium, tellurium, boron, carbon, silicon, phosphorus, arsenic, antimony, bismuth, the alkali metals, beryllium, and magnesium. Also describes chemical reactions of the calcium ion and detection and determination of calcium, strontium, and barium. - Literature closing date: end of 1949. 1961. 133 figs. LXVI, 912 pages (in German). Cloth
ISBN 3-540-93042-6

Cadmium - Cd

Main Volume

Describes the element and its compounds. Chemical reactions of cadmium compounds are treated separately from those of the cadmium ion. - Literature closing date: July 1924.
1925, reprint 1974. 23 figs. XX, 214 pages (in German).
Cloth ISBN 3-540-93258-5

Supplement Volume

Covers the element (including special sections on the Weston cell and the nickel-cadmium storage battery), alloys, and compounds (including an extensive section devoted to addition and complex compounds of cadmium with inorganic and organic ligands). A formula index and an alphabetic subject index are provided. - Literature closing date: end of 1949. 1959. 218 figs. XCVIII, 802 pages (in German). Cloth
ISBN 3-540-93036-1

Chlorine - Cl

Main Volume

History and occurrence. Formation, preparation, physical properties, electrochemical behavior, and chemical reactions of the element and its compounds: chlorine hydrate, hydrogen chloride (with a review of the chlorides), the oxides, the chlorooxoacids (with a review of their salts), compounds of chlorine with nitrogen (including a detailed discussion of aqua regia), and compounds of chlorine with fluorine. -
Literature closing date: June 1927.
1927, reprint 1963. 9 figs. XXXIV, 442 pages (in German).
Cloth ISBN 3-540-93043-4

Supplement Volume

Part A: **The Element (Excluding Detection and Determination)**

Technology of chlorine and its compounds, including procedures for enrichment and separation of the chlorine isotopes. The chlorine atom, atomic ions, molecules, and molecular ions. The major portion is devoted to the physical properties, electrochemical behavior, chemical reactions, aqueous and non-aqueous solutions, and toxicity of chlorine. - Literature closing date: end of 1964. 1968. 47 figs. XXIX, 396 pages (in German).
Cloth
ISBN 3-540-93044-2

Part B: **The Compounds**

Section 1: **Compounds up to Chlorine and Hydrogen**

Treats the following in detail: the chlorine-hydrogen gas reaction; the HCl and DCl molecules and their physical properties; electrochemical behavior of HCl in solution; chemical reactions of gaseous HCl; aqueous and nonaqueous solutions of HCl; behavior of Cl^- in solutions, melts, and solids. - Literature closing date: end of 1964. 1968. 72 figs. XX, 314 pages (in German). Cloth
ISBN 3-540-93045-0

Section 2: **Compounds** (Continued). **Detection and Determination**

Covers the oxides of chlorine (including their thermal and photochemical decomposition), chlorooxoacids, chlorine-nitrogen compounds, chlorine-fluorine compounds, and the analytical chemistry of chlorine. - Literature closing date: end of 1966. 1969. 40 figs. XXIII, 308 pages (in German). Cloth
ISBN 3-540-93046-9

Cobalt - Co

Main Volume

Part A: **History. Occurrence. The Element. Cobalt Compounds** (Except for Cobalt Ammines)

Section **1: History. Occurrence. The Element and Its Alloys**

History and occurrence; industrial recovery of cobalt compounds from ores and intermediates; preparation and properties of the element; alloys of cobalt. -
Literature closing date: mid-1931.
1932, reprint 1969. 19 figs. XV, 220 pages (in German).
Cloth ISBN 3-540-93095-7

Section 2: **Cobalt Compounds** (Except for Cobalt Ammines)

Cobalt compounds except for those with Fe, Cu, Ag, Au, the platinum-group elements, Tc, Re, and the transuranium elements. "Cobalt Ammines" are treated in Part B. -
Literature closing date: end of 1931.
1932, reprint 1972.14 figs. XXX, 282 pages (in German).
Cloth ISBN 3-540-93096-5

Part B: **Cobalt Ammines**

Complexes of cobalt. Ligands are NH_3, amines, pyridine, etc. The arrangement is by the anion for the Co^{II} compounds, and by type of compound for the Co^{III} compounds. Polynuclear complexes conclude the volume. -
Literature closing date: end of 1929.
1930, reprint 1968. 2 figs. LXI, 376 pages (in German).
Cloth ISBN 3-540-93098-1

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.
1961. 188 figs. LXXVI, 886 pages (in German). Cloth
ISBN 3-540-93097-3

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 (H_2O, NH_3, and N_2H_4) and those with organic ligands. -
Literature closing date: end of 1949.
1963. 48 figs. XXII, 314 pages (in German). Cloth
ISBN 3-540-93099-X

Section 2: **Cobalt(III) Compounds**

Contains the complex compounds of trivalent cobalt with neutral, inorganic, and organic ligands arranged by type, e.g., $[CoA_6]X_3$, $[CoXA_5]X_2$, where A is a neutral ligand like NH_3, 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 figs. 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)

Covers mononuclear organometallic compounds of cobalt, including the carbonyls. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1971. 1973. 85 figs. XXII, 527 pages (in German). Cloth
ISBN 3-540-93246-1

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

Covers polynuclear organometallic compounds of cobalt, including the carbonyls. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1971. 1973. 103 figs. XIV, 243 pages (in German). Cloth
ISBN 3-540-93247-X

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 figs. XXIV, 418 pages (in German). Cloth
ISBN 3-540-93047-7

Section 2: **Electrochemistry. Chemical Reactions. Alloys**
Discusses electrochemical behavior, with special consideration of plating processes. Also covers chemical reactions of metallic chromium, general reactions and chemical behavior of the ions, detection and determination, and alloys of chromium from those with antimony to those with tantalum. - Literature closing date: end of 1949. 1963. 111 figs. XXII, 312 pages (in German). Cloth
ISBN 3-540-93048-5

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 are double salts, such as $KCr(SO_4)_2$, or salts with chromium in the anion, such as $K2CrO_4$. The volume concludes with compounds containing Ta. - Literature closing date: end of 1949. 1962. 74 figs. 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 Cr^0 to Cr^{VI}. 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 alkylammines, 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 figs. XLVIII, 431 pages (in German). Cloth
ISBN 3-540-93050-7

Organochromium Compounds

(New Suppl. Ser. Vol. 3)

Bound together with: **Organovanadium Compounds** (New Suppl. Ser. Vol. 2), See "V" Vanadium.

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 figs. 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 figs. 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.
1955, reprint 1978. 190 figs. XXXVI, 710 pages (in German). Cloth ISBN 3-540-93109-0

Section 2: **The Element** (Formation and Preparation. Physical Properties. Electrochemical Behavior and Chemical Reactions. Toxicity. Detection and Determination)

A lengthy section dealing with electrolytic deposition of copper is provided in the chapter "Electrochemical Behavior". - Literature closing date: end of 1949.
1955, reprint 1974. 235 figs. XXXVIII, 755 pages (in German). Cloth ISBN 3-540-93266-6

Part B: **The Compounds**

Section 1: **Copper Compounds up to Copper Tellurates**

Hydrides, oxides, hydroxides (including ammoniacal solution of Cu^{II} 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.
1958, reprint 1971. 58 figs. LIX, 624 pages (in German). Cloth ISBN 3-540-93110-4

Section 2: **Compounds from Copper and Boron to Copper and Bismuth**

Compounds with B, C, Si, 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.
1961. 38 figs. XLV, 352 pages (in German). Cloth ISBN 3-540-93111-2

Section 3: **Compounds from Copper and Lithium to Copper and Iron. Reactions of Copper Ions**

Compounds contain alkali metals including salts with NH_4, 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 acidocuprate 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 Cu_2O 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.
1963. 136 figs. XIV, 168 pages (in German). Cloth ISBN 3-540-93114-7

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 R_2CuLi, RR'CuLi, R_2CuMgX, 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 RC=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^+, HF^-, and HF_2^- 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 hyperfluorous acid HOF. The second part deals with the binary fluorine-nitrogen compounds such as NF_4, NF_3, NF_2, NF, N_2F_4, N_2F_2, and N_3F 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 NO_x-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

Perfluorohalogenoorgano Compounds of Main Group Elements

Part 1: **Compounds of Sulfur** (New Suppl. Ser. Vol. 9)

This first volume of the series is dedicated to H.J. Emeléus. It begins coverage of the perfluorohalogenoorganosulfur(II) compounds. - Literature closing date: end of 1971. 1973. XIV, 217 pages (in German). Cloth
ISBN 3-540-93250-X

Part 2: **Compounds of Sulfur** (Continued), **Selenium, and Tellurium** (New Suppl. Ser. Vol. 12)

Continues the treatment of S^{II} compounds begun in Part 1 and then describes compounds with S^{IV} and S^{VI}. Corresponding compounds of selenium and tellurium are also covered. A formula index for Parts 1 and 2 is included. - Literature closing date: end of 1971. 1973. XII, 247 pages (in German). Cloth
ISBN 3-540-93273-9

Part 3: **Compounds of Phosphorus, Arsenic, Antimony, and Bismuth** (New Suppl. Ser. Vol. 24)

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 3-540-93293-3

Part 4: **Compounds with Elements of Main Groups 1 to 4** (Excluding Carbon) (New Suppl. Ser. Vol. 25)

Covers perfluorohalogenoorgano compounds of Na, K, Li, Be, Ca, Mg, B, Al, Ga, In, Tl, 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).
ISBN 3-540-93378-6

Part 7: **Aliphatic and Aromatic Nitrogen Compounds**

Starts the treatment of the aliphatic and aromatic perfluorohalogenoorgano 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 perfluorohalogenoorgano compounds of nitrogen, describing the nitro compounds, the compounds with N-N bonds, and compounds with nitrogen-halogen 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); perfluorohalogenoorganoazaalkenes; and tertiary perfluorohalogenoorganoamines. 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 l 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 starts the description of compounds with the elements of main group 6 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**

Completes the treatment of the sulfur(II) compounds. Covers the sulfur(II) heterocyclic compounds, fused ring systems, thiols, sulfanyl nitrogen compounds, sulfenyl halides, sulfanes, and sulfur(II) compounds of boron, phosphorus, arsenic, antimony, and metals. - Literature closing date: end of 1981.
1986. 8 figs. XI, 269 pages. Cloth

ISBN 3-540-93538-X

Volume 3: **Compounds with Elements of the Main Group 6 (S^{IV}, S^{VI}, 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 sulfonates, sulfur(VI) oxides, sulfonyl nitrogen compounds, sulfonyl 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 perfluorohalogenoorgano 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 perfluorohalogenoorgano 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 aminooxy 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**

Deals with perfluorohalogenoorgano compounds with pseudo-halide groups (-CN, -NC, -NCO, -NCS, > NCN), with perfluorohalogenoorganoazaalkenes, and with tertiary perfluorohalogenoorganoamines. Formula index for Supplement Volumes 5 and 6. -
Literature closing date: end of 1985.
1991. 1 fig. XIII, 283 pages. Cloth ISBN 3-540-93633-5

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

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

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

Section 2: **Physical Properties of Pure Iron. Electrochemical Behavior of Pure and Technical Iron**

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 3: **Passivity, Chemical Reactions, and Corrosion of Pure and Technical Iron, Metallurgy of Iron**

Also covers manufacture of pig iron and of malleable iron by the direct method. - Literature closing date: 1930.
1930, reprint 1979. 28 figs. XIV, 274 pages (in German).
Cloth ISBN 3-540-93054-X

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.
1932, reprint 1974. 174 figs. XII, 260 pages (in German).
Cloth ISBN 3-540-93055-8

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.
1933, reprint 1971. 213 figs. XVI, 320 pages (in German).
ISBN 3-540-93056-6

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. XXXIV, 583 pages (in German). Volume lb: 1964. 668 figs. German and English Subject Index. IV, 344 pages. Cloth,
ISBN 3-540-93252-6

Volumes 2a and 2b: **General Requirements for the Commercial Reduction of Iron Ore. Raw Materials. The Technology of Iron Ore Reduction Processes Outside of the Blast Furnace**

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).
Volume 2b: 1968. 452 figs. German and English Subject Index. IV, 188 pages. Cloth,
ISBN 3-540-93253-4

Volumes 3a and 3b: **Blast Furnace, Part I: Blast Furnace Plant. Blast Furnace Practice. Pig Iron and By-products. Iron Production in the World**

Covers practical aspects of blast furnace equipment, operation, and products. - Literature closing date: 1968/69.
Volume 3a: 1971. XV, 320 pages (in German).
Volume 3b: 1971. 304 figs. German and English Subject Index. VIII, 137 pages. Cloth,
ISBN 3-540-93254-2

Volumes 4a and 4b: **Blast Furnace, Part 2: Blast Furnace Process. Relationship Between Operating Conditions and Results. Mathematical Models and Automation**

Contains discussions of blast furnace theory. -
Literature closing date: **1969/70.**
Volume 4a: 1972. XII, 353 pages (in German).
Volume 4b: 1972. 327 figs. German and English Subject Index. VIII, 160 pages. Cloth, together,
ISBN 3-540-93255-0

Volumes 5a and 5b: **Theory of Steelmaking, Part I: The Term Steel. Steelmaking Methods. Theoretical Principles: Constitution of Steel Melts. Constitution of Steelmill Slags. Use of Theoretical Principles in the Analyses of the Processes Occurring During Refining and Treatment of Steel**

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

Volumes 6a and 6b: **Theory of Steelmaking, Part a: Kinetic Principles of Steelmaking. Formation and Behavior of Nonmetallic Phases in the Iron Bath. Principles of Solidification of Steel Melts**

The second volume on the theory of steelmaking discusses the kinetics: transport processes, formation of new phases, and interfacial properties. There is a chapter on the formation and behavior of nonmetallic phases, especially deoxidation products and gas bubbles. Solidification of steel includes nucleation, crystal growth, heat flow, and segregation. The volume concludes with a discussion of the solidification of steel in practice. - Literature closing date: 1976. Volume 6a: 1978. XXVI, 232 pages (in German). Volume 6b: 1978. 241 figs. German and English Subject Index. X, 158 pages. Cloth,
ISBN 3-540-93366-2

Volumes 7a and 7b: **Practice of Steelmaking, Part l: Charge Materials and Additives. Sampling and Temperature Measurement. Unfired Processes**

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.
Volume 7b: 1984. 517 figs. English and German Subject Index. X, 352 pages. Cloth,
ISBN 3-540-93495-2

Volumes 8a and 8b: **Practice of Steelmaking, Part 2: The Open Hearth Process, The Electric Arc Furnace Process, Induction Furnace Melting, New Electric Steelmaking Processes, Continuous Steelmaking**

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. English and German 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**

This volume covers the secondary metallurgy of steelmaking, i.e., operations which supplement the basic melting process. Deoxidation, desulfurization and dephosphorization of liquid steel, gas purging processes, vacuum metallurgy, and the production of low-carbon high-chromium steels are discussed. The remelting processes treated include vacuum arc, electroslag, and electron beam remelting. Automation of the basic oxygen and electric furnace processes supplements the process descriptions of Volumes 7 and 8. - Literature closing date: 1986.
Volume 9a: 1988. XIX, 346 pages.
Volume 9b: 1988. 548 figs. English and German Subject Index. XI, 300 pages. Cloth,
ISBN 3-540-93558-4

Volumes 10a and 10b: **Practice of Steelmaking, Part 4: Ingots. Castings. Powder Metallurgy**

This volume covers ingot casting, mold casting, and the powder metallurgy of steel. Discussions on the quality of ingots and semifinished products, on the detailed steps of various powder metallurgical processes, and on special material and product properties extend the scope of the series. - Literature closing date: end of 1990. Volume 10a: 1992. XVI, 209 pages.
Volume 10b: 1992. 257 figs. English and German Subject Index. XI, 182 pages. Cloth,
ISBN 3-540-93643-2

Volumes 11a and l1b: **Practice of Steelmaking, Part 5: Continuous Casting**

This volume is entirely devoted to continuous casting of steel. The engineering and the operation of continuous casting are treated in great detail. Much attention is given to the metallurgical processes from the viewpoint of product quality. - Literature closing date: end of 1991.
Volume 1 la: 1992. XIV, 357 pages.
Volume lib: 1992. 695 figs. IX, 452 pages.
Cloth, together, ISBN 3-540-93654-8

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

This volume gives a retrospective and an outlook for the future of steelmaking processes (the future evolution of the steel industry, the trends in steel consumption, the steel production, and its geographical repartition, raw materials). Energy sources are reviewed in view of the necessity to reduce CO2 emission and to comply with stricter ecological constraints. - Literature closing date: end of 1990. Volume 12a: 1992. XXII, 270 pages.
Volume 12b: 1992. 401 figs. English and German Subject Index. XVIII, 262 pages. Cloth, ISBN 3-540-93644-0

Division II

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**

Covers systems of iron with sulfur, selenium, tellurium, and boron. Begins coverage of the iron-carbon system: the phase diagram, individual carbide phases, solidification and cooling of carbon steels, annealing, surface decarburization, forming, hardening, tempering, and case hardening. -
Literature closing date: January 1934.
1934, reprint 1975. 146 figs. XX, 254 pages (in German).
Cloth ISBN 3-540-93260-7

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

Covers magnetic and electrical properties of pure iron and its carbon-based composites. - Literature closing date: June 1934.
1934, reprint 1970. 120 figs. XVI, 214 pages (in German).
Cloth ISBN 3-540-93058-2

Section 8: **Fe-C System (Continued): Mechanical and Thermal. Properties of Pure and of Carbon-Containing Iron. Iron Systems from Fe-C-H to Fe-Be-K**

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 quarternary 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, nitrides, azides, nitrosyls, nitrites, nitrates, and halides. The ammonia addition compounds (formerly known as "am-mines") are covered under the salts from which they are derived; for example, $FeCl_2.10\ NH_3$ 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)**

Iron-carbon compounds, including the thiocarbonates, iron salts of organic acids, and cyanides. - Literature closing date: May 1930.
1930, reprint 1967. XV, 144 pages (in German).
Cloth ISBN 3-540-93061 -2

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, thiocyanate, 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 NH_4, 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**

Physical fundamentals of notch impact strength, measurement methods, and relationships to other mechanical properties. - Literature closing date: October 1938. 1939, reprint 1969. 208 figs, and 8 pages of photographs. XVI, 288 pages (in German).
Cloth
ISBN 3-540-93065-5

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

Supplement Volume 1 for "Iron" Part A, Section 7, and "Iron" Part D: **Magnetic and Electrical Properties of Iron and Its Alloys**

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 F: **Detection and Determination of Foreign Elements in Iron and Steel**

Division I. Sections 1 and 2: **Accompanying and Alloying Elements**

Analysis of iron and steel: sampling; detection and determination of gases; detection and determination of accompanying and alloying elements (C, Mn, Si, S, P, As, Sb, and Bi). - Literature closing date: mid-1939 and January 1940.
1939 and 1941, reprint 1967. 36 figs. XXX, 430 pages (in German). Cloth ISBN 3-540-93264-X

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**

Continues detection and determination of foreign elements in iron and steel: Ti, Al, Ce, Th, Ni, and Co. Also describes special analytical methods, and outlines, by country, standard analytical procedures. Concludes with a comprehensive subject index for Parts F I and F II. - Literature closing date: May 1939.
1939, reprint 1969. 12 figs. XXIV, 224 pages of text and 110 pages of subject index for Part F (in German). Cloth
ISBN 3-540-93071-X

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, FeH_2, and the solid phase ε-$FeH_{0.8}$ are known. - Literature closing date: end of 1989. 1991. 70 figs. XX, 336 pages. Cloth
ISBN 3-540-93621-1

Organoiron 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 2: **Ferrocene 2** (Mononuclear Monosubstituted Ferrocene Derivatives with Oxygen-Containing Substituents, Part 1: Alcohols and Phenols, Esters of Carboxylic Acids of the Type fc-A-OOC-R, Ethers, Aldehydes, and Ketones of the Type fc-CO-R) (New Suppl. Ser. Vol. 49)

Continues the treatment of ferrocene compounds. Describes the alcohols, phenols, esters of carboxylic acids, ethers, aldehydes, and ketones derived from ferrocene. - Literature closing date: end of 1976.
1977. 1 fig. XII, 303 pages (in German). Cloth
ISBN 3-540-93350-6

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 3-540-93354-9

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

Treats the monosubstituted ferrocenes $C_5H_5FeC_5H_4R$ in which R contains nitrogen. Thus included are amines, amides, compounds with C=N bonds, cyanides, 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 3-540-93425-1

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

Major sections deal with $C_5H_5FeC_5H_4R$ ferrocene derivatives in which R contains sulfur, boron, silicon, or phosphorus. Contains an empirical formula index and a ligand formula index for volumes A 1 through A 5. -
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 biferrocenylene, 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 $FeC_{10}H_8R^1R^2$. Complete coverage is given for compounds in which R^1 and R^2 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 most important of these compounds is $Fe(C_5H_4COCH_3)_2$. 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 $FeC_{10}H_8R^1R^2$ is continued. At least the substituent R^1 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)**

Covers over 1000 mononuclear unbridged di- and all trisubstituted ferrocenes and their chemical, physical, and catalytic properties. Major chapters are on ferrocenes with P-containing substituents and on ferrocenes with Li-containing substituents. Contains a formula index. - Literature closing date: 1986. 1991. 25 figs. XIII, 365 pages. Cloth
ISBN 3-540-93640-8

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

Covers all unbridged tetra-to decasubstituted ferrocenes, their irons and salts. Contains a formula index and transition metal cross reference. - Literature closing date: 1993. 1995. 46 figs. XII, 207 pages. Cloth
ISBN 3-540-93709-9

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 $(CO)_4Fe$ 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.
ISBN 3-540-93359-X

Section 3: **Mononuclear Compounds** 3

Completes 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 dosing 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 (^{3}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 $^4LFe(CO)_n$ ($^2D)_{3-n}$ are described where n = 0 to 2. Also, compounds of the type $^4LFe(CO)_3$, where ^{4}L includes butadiene and its derivatives and other acyclic ligands bound 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 $^4LFe(CO)_3$ where ^{4}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 $^4LFe(CO)_3$. The ^{4}L ligands covered include, among others, cyclic hexa-l,3-dienes and hexa-l,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 $^4LFe(CO)_3$ with seven-, eight-, and nine-membered ring systems. Examples of the ^{4}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 $^4LFe(CO)_3$ compounds is continued; the second part contains compounds with a ^{4}L ligand and one or two ^{2}L ligands. The compounds in the third part have a ^{4}L and a ^{3}L ligand, while those in the fourth part have two ^{4}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 ^{5}L ligands, especially those in which ^{5}L = cyclopentadienyl. This volume deals with ^{5}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 $^5LFe(CO)_2X$ 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 $^5LFe(CO)_2$ unit, concluding with compounds of the type $[^5LFe(CO)_2(^2D)]X$. The last chapter covers compounds of the type $C_5H_5Fe(CO)_2R$, 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 $C_5H_5Fe(CO)_2R$ compounds. In this case, R represents an alkyl group substituted by a heterocyclic ring or an acyl, iminoacyl, thioacyl, alkenyl, alkynyl, aryl, or other carbocyclic substituent. - 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 $C_5H_5Fe(CO)_2R$ compounds: compounds with heterocyclic R, as well as compounds in which R contains carboranyl groups, or $Co_2(CO)_6$. A further section treats $^5LFe(CO)_2R$ compounds having ^{5}L ligands other than C_5H_5. $[^5LFe(CO)_2]^-$ anions and their salts, as well as ions and radicals containing the $^5LFe(CO)_2$ 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 $[^5LFe(CO)_3]^+$ 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 CS or isocyanide ligands; C_5H_5 is the dominant ^{5}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 ^{5}LFe=CRR' unit. The most important are the rather unstable $[^5LFe(CO)(^2D)=CRR']^+$ cations with a chiral Fe atom. The electrophilic properties of the prochiral =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}LFe compounds with additional ^{2}L ligands such as alkenes, alkynes, allenes, 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 ^{5}L ligands and completes the description of ^{5}LFe compounds with additional ^{2}L ligands and two CO groups, especially cations of the type $[^{5}LFe^{2}L(CO)_{2}]^{+}$. The following chapters deal with ^{5}LFe compounds with additional ^{3}L or ^{4}L ligands. The last chapter is devoted to compounds with two ^{5}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 ^{6}L ligand and additional ligands bonded by heteroatoms or ^{1}L to ^{4}L ligands. $^{6}LFe^{5}L$ compounds contain benzene or monosubstituted benzenes as ^{6}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 ^{6}L ligand and one ^{5}L ligand. The description of compounds with two ^{6}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: 1990. 1992. 49 figs. XXIV, 439 pages. 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 $Fe_{2}(CO)_{9}$ and concludes treatment of binuclear organoiron compounds with ^{1}L ligands. Compounds with ^{2}L ligands and ^{3}L 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 treatment of compounds with ^{5}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 ^{5}L ligands: (a) carbonyl compounds with two ^{5}L ligands and two or three bridging groups of various types, with major attention to $(C_{5}H_{5}Fe(CO)_{2})_{2}$, and (b) compounds containing additional ^{1}L (other than carbonyl) and ^{2}L, ^{3}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 $^{6}LFe_{2}(CO)_{n}$ and $^{8}LFe_{2}(CO)_{n}$ types, where n is 4 to 7. The very few Lewis base (^{2}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 $Fe_{3}(CO)_{n}$, n = 3 to 9, compounds and clusters with a $Fe_{3}M_{n}$ 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 $Fe_{3}(CO)_{n}$ 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 ^{2}D ligands. $F_{3}M_{x}$-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 $Fe_{3}(CO)_{12}$ and Fe_{3} compounds with ^{n}L ($n \geq 2$). Polynuclear compounds with Fe_{4} to Fe_{6}, 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, Cu, 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 C: **Compounds**

Section 2: **Compounds with N**

Comprises the binary gallium-nitrogen compounds, such as GaN, $Ga(N_3)_3$, the ion $[Ga(N_3)]^{2+}$, and all known compounds composed of gallium, nitrogen, and hydrogen, e.g., cyclotrigalazane and gallium amide, as well as those composed of gallium, nitrogen, oxygen, and hydrogen, e.g., the oxide nitride, nitrite and nitrates of gallium. The description of the chemistry and the basic physical properties of GaN covers most of the volume. - Literature closing date: end of 1993. 1996. 32 figs. XIII, 230 pages. Cloth

ISBN 3-540-93731-5

Part D: **Coordination Compounds**

Section 1: **Coordination Compounds 1**

Describes the few known Ga^0, Ga^I, Ga^{II}, and above all the Ga^{III} 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

Section 2: **Coordination Compounds 2**

Continues the treatment of complexes with N-containing ligands and includes complexes with N- and O-containing ligands. Ligands are heterocycles, amino alcohols, amino carboxylic acids, amides, proteins, hydrazides, hydroyamic acids, oximes, amine oxides, etc. - Literature closing date: 1993. 1995. 32 figs. XIV, 264 pages. Cloth

ISBN 3-540-93708-0

Section 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 Dl to D3. - Literature closing date: 1993. 1995. 27 figs. XV, 397 pages. Cloth

ISBN 3-540-93717-X

Organogallium Compounds

Part I:

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 Ti^6-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

Describes the element and its compounds. -
Literature closing date: May 1931.
1931, reprint 1961. 2 figs. X, 62 pages (in German).
Cloth ISBN 3-540-93075-2

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. IIL, 576 pages (in German).
Cloth ISBN 3-540-93076-0

Organogermanium Compounds

Part 1: **Tetraorganogermanium Compounds**

Contains tetraorganogermanium compounds of the type GeR_4 and begins the treatment of type GeR_3R' compounds. - Literature closing date: through 1985. 1988. 6 figs. XV, 232 pages. Cloth

ISBN 3-540-93568-1

Part 2: **$Ge(CH_3)_3R$ and $Ge(C_2H_;)_3R$ Compounds**

Continues the treatment of the tetraorganogermanium compounds, and completes the description of compounds of the type $Ge(CH_3)_3R$. These are followed by the triethyl compounds, $Ge(C_2H_5)_3R$. - Literature closing date: 1985.
1989. 3 figs. XI, 398 pages. Cloth

ISBN 3-540-93585-1

Part 3: **Tetraorganogermanium Compounds from $Ge(C_3H_7)R$ to GeRR'R"R"' and Other Organogermanium Compounds with Low-Coordinate Germanium Atoms**

Completes the description of the GeR_3R' compounds and includes compounds of types GeR_2R_2 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. - Literature closing date: 1987.
1990. 20 figs. XV, 518 pages. Cloth

ISBN 3-540-93595-9

Part 4: **Compounds with Germanium-Hydrogen Bonds**

Describes the mononuclear organogermanium compounds of the GeR_3H, GeR_2H, and $GeRH_3$ types. Contains an empirical formula index and a ligand formula index. -
Literature closing date: end of 1992.
1994. 6 figs. XIV, 364 pages. Cloth

ISBN 3-540-93696-3

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 $R_3GeOGeR_3$ type as well as bi- and trinuclear 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 triorganogermaniummonochloride compounds, i.e., compounds of the types GeR_3Cl, $GeR_2R'Cl$, and GeRR'R"Cl. Empirical formula index. - Literature closing date: 1994. 1996. 9 figs. XIV, 260 pages. Cloth ISBN 3-540-93730-7

Hydrogen - H

Main Volume

History of hydrogen; formation and preparation of the element, physical properties, electrochemical behavior, chemical reactions, detection, and determination of H_2 and the H^+ ion. Atomic and triatomic hydrogen are also covered. - Literature closing date: end of 1926.
1927, reprint 1963. 3 figs. XVII, 273 pages (in German). Cloth ISBN 3-540-93236-4

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

Supplement Volume

Generally follows the arrangement of the Main Volume. Separation of Hf and Zr by precipitation, dissolution, partition, and distillation methods (tetrachlorides) is given extensive coverage. Compounds covered contain deuterium, B, C, N, P, halogens, and Sr. - Literature closing date: end of 1949. 1958. 1 fig. X, 23 pages (in German). Cloth ISBN 3-540-93081-7

Organohafnium Compounds (New Suppl. Ser. Vol. n)

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

Mercury - Hg

Main Volume

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

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.
1960. 53 figs. XIX, 466 pages (in German). Cloth
ISBN 3-540-93173-2

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.
1968. 66 figs. XXV, 346 pages (in German). Cloth
ISBN 3-540-93177-5

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 iodine-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

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

Iridium - Ir

Main Volume

Covers the element and its compounds in the usual sequence; special chapters on the complex ammines of tri- and tetravalent iridium. The early literature on element 95, "ekairidium", is covered. For iridium alloys, see "Pt" Platinum Part A, Section 6. - Literature closing date: March 1939.
1939, reprint 1971. 3 figs. XXIV, 196 pages (in German). Cloth

ISBN 3-540-93083-3

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 3-540-93382-4

Section 2: **Compounds**

Covers the binary compounds of iridium with H, B, C, Si, N, P, As, Sb, the chalcogens, and the halogens, their double salts, and the iridium 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

Potassium - K

Main Volume

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

History, occurrence, formation and preparation, physical properties, electrochemical behavior, and chemical reactions of the element. Detection and determination. Compounds with hydrogen and oxygen. - Literature closing date: April 1936.
1936, reprint 1970. 7 figs. XIV, 246 pages (in German).

ISBN 3-540-93086-8

Section 2: **Compounds up to Potassium and Chlorine**

Covers compounds of potassium with nitrogen, fluorine, and chlorine. - Literature closing date: October 1936.
1937, reprint 1963. 12 figs. XX, 268 pages (in German). Cloth

ISBN 3-540-93087-6

Section 3: **Compounds up to Potassium and Tellurium**

Covers compounds with bromine, iodine, sulfur, selenium, and tellurium. - Literature closing date: April 1937.
1937, reprint 1963. 17 figs. XXIV, 290 pages (in German). Cloth

ISBN 3-540-93088-4

Section 4: **Compounds up to Potassium Acetate**

Compounds of potassium with boron and carbon (carbides, carbonyls, salts of carbonic and thiocarbonic acid, carbamates, cyanides, cyanates including thio-, seleno-, and tellurocyanides, and salts of formic and acetic acid). -
Literature closing date: August 1937.
1937, reprint 1963. 6 figs. XV, 128 pages (in German). Cloth

ISBN 3-540-93089-2

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**

Covers the industrial preparation of potassium salts from crude potassium salts, from potassium aluminium silicates, from organic raw materials, and from natural alkaline brines. -
Literature closing date: June 1938.
1938, reprint 1963. 2 figs. XI, 108 pages (in German).
Cloth ISBN 3-540-93092-2

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, SO_4), with or without H_2O, 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 H_2O. 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

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

Magnesium - Mg

Main Volume

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

Section 1: **History. Occurrence. Preparation of the Metal**

Describes industrial preparation by electrolytic and chemical processes. Contains chapters on purification, casting, and subsequent treatment. - Literature closing date: April 1937.
1937, reprint 1965. 1 fig. IX, 156 pages (in German).
Cloth ISBN 3-540-93117-1

Section 2: **Properties of the Metal**

Covers the physical properties of the metal, electrochemical behavior, chemical reactions, and detection and determination. - Literature closing date: May 1937.
1937, reprint 1965. 13 figs. XII, 216 pages (in German).
Cloth ISBN3-540-93118-X

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

Covers the alloys of magnesium with silicon up to those with radium. - Literature closing date: May 1942.
1942, reprint 1970. 56 figs. VIII, 110 pages (in German).
Cloth ISBN 3-540-93119-8

Section 4: **Alloys from Magnesium and Zinc to Magnesium and Rhenium. Surface Treatment**

Covers magnesium alloys known so far with all metals, except those described in Section 3. Ternary and quarternary alloys are described in addition to the binary alloys. -
Literature closing date: end of 1949.
1952, reprint 1973. 96 figs. XXIV, 336 pages (in German).
Cloth ISBN 3-540-93120-1

Part B: **The Compounds**

Section 1: **Compounds up to Magnesium and Iodine**

Covers compounds of magnesium with hydrogen, oxygen, nitrogen, and the halogens. - Literature closing date: August 1937. 1937, reprint 1963. 15 figs. XIX, 200 pages (in German).
Cloth ISBN 3-540-93121-X

Section 2: **Compounds up to Magnesium Carbonates**

Compounds of magnesium with sulfur, selenium, tellurium, boron, and carbon (carbides and carbonates including thio- and perthiocarbonates). - Literature closing date: end of 1937.
1938, reprint 1963. 4 figs. XIII, 130 pages (in German).
Cloth ISBN 3-540-93122-8

Section 3: **Compounds up to Magnesium and Bismuth**

Covers compounds of magnesium with carbon (cyanides, cyanates including thio-, 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 hydroxylammonium, 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

Manganese – Mn

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 M_3O_4)**

Introduces the crystal-chemical relationships between M_3O_4-type Mn oxides. Describes in the main part the occurrence, chemistry, and properties of hausmannite and the Zn-containing analogue hetaerolite-hydrohetaerolite. -
Literature closing date: 1993.
1995. 19 figs. XI, 210 pages. Cloth

ISBN 3-50-93726-9

Section 3b: **Minerals (Oxides of Type M_3O_4)**

Continues the description of the Mn minerals of the M_3O_4 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 M_3O_4)**

Covers the Mn minerals of the M_2O_3 type (cubic bixbyite, trigonal and tetragonal oxides of the corrundum-ilmenite group, trigonal and monoclinic oxides of the crichtonite group). -
Literature closing date: 1992. 1994. 13 figs. XI, 220 pages. Cloth

ISBN 3-540-93700-5

Section 5b 1: **Minerals (MO_2-Type Tunnel Oxides)**

Covers the Mn minerals of the MO_2 type with a tunnel structure which belong to the hollandite group (hollandite, cryptomelane, manjiroite, 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 Mn^{I}, Mn^{II}, and Mn^{III} 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**

Considerable space is devoted to the coverage of pyrolusite, in view of its extensive literature and its industrial significance. - Literature closing date: end of 1972. 1973. 117 figs. XXIV, 423 pages (in German). Cloth

ISBN 3-540-93126-0

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 MnO_4^{3-}, MnO_4^{2-} MnO_4^{-}, and $HMnO_4$. The major portion of the volume then covers compounds and phases of the various oxidation states of Mn with the alkali metals (including NH_4 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**

Binary compounds of manganese and fluorine: the binary fluorides, their hydrates and solutions, and the fluoromanganate ions. Emphasis is on MnF_2 and its magnetic properties. Ternary compounds of manganese and fluorine. Here too, the emphasis is on the magnetic properties of the numerous alkali fluoromanganates. - Literature closing date: 1976. 1977. 109 figs. XXIV, 273 pages (in German). Cloth

ISBN 3-540-93343-3

Section 5: **Compounds of Manganese with Chlorine, Bromine, and Iodine**

The major portion of this volume is devoted to manganese compounds of chlorine: MnCl, $MnCl_2$ and its hydrates, $MnCl_3$, $MnCl_4$; the chloro complexes of Mn^{II}, Mn^{III}, and Mn^{IV}; 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 ($MnSO_4$), 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 l 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 l**

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 (III) acetate is an oxidant in organic chemistry and the starting material for a series of manganese (III) compounds. The cyano- and cyanonitrosyl-manganates 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 porphyrin 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, hydrazinecarboxylic 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, thiocarbazones, 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 $Mn(R_3P)X_2$ 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

Supplement Volume

Part A: **The Element**

Section 1: **The Metal. Its Technology**

Covers the technology of molybdenum metal with chapters on recovery from ores and by-products, on metal preparation, on special production technology, on the manufacture of special forms, and on the use of the metal. -
Literature closing date: end of 1976.
1977. 21 figs. XIV, 207 pages (in German). Cloth
ISBN 3-540-93348-4

Section 2a: **Element. Physical Properties, Part l**

Molybdenum isotopes and properties of the molybdenum atom and ions. Crystallographic, mechanical, and thermal properties of molybdenum. - Literature closing date: mid-1984. 1985. 116 figs. XVII, 489 pages. Cloth
ISBN 3-540-93519-3

Section 2b: **Physical Properties, Part 2. Electrochemistry**

Electrical, magnetic, and optical properties, as well as particle emission phenomena. The complex electrochemical behavior is described in great detail. - Literature closing date: mid-1985.
1988. 69 figs. XVII, 352 pages. Cloth
ISBN 3-540-93566-5

Section 3: **Metal. Chemical Reactions**

The volume is devoted to the chemical reactions of molybdenum metal, which have been thoroughly investigated for this element of outstanding technological importance. Among the many topics covered are adsorption and desorption of hydrogen, the reactions with oxygen and other gases (e.g., CO, CH_4), the reactions with acids, solutions of alkalis and salts, molten alkali metals, heavy metals, and organic compounds. - Literature closing date: 1979.
1983. 14 figs. XV, 227 pages. Cloth
ISBN 3-540-93475-8

Part B: **Compounds**

Section 1: **Compounds with Noble Gases, Hydrogen, and Oxygen. Anhydrous Antimony, Bismuth, and Alkali Molybdates**

Includes a special chapter reviewing the molybdenum oxide bronzes. These nonstoichiometric compounds of Mo, O, and a third element (alkali, alkaline earth, etc.) display unusual physical and chemical properties. -
Literature closing date: mid-1974.
1975. 97 figs. XVI, 241 pages (in German). Cloth
ISBN 3-540-93297-6

Section 2: **Compounds of Molybdenum Oxides with Oxides of Other Metals**

Continues the description of anhydrous molybdates. Alkaline earth and rare earth molybdates are covered in extensive chapters. - Literature closing date: end of 1974. 1976. 119 figs. XLIV, 320 pages (in German). Cloth
ISBN 3-540-93316-6

Section 3a: **Oxide Hydrates. Molybdate Ions**

In the first part of this volume the oxide hydrates including the hydroxides and hydroxide oxides of Mo^{III} to Mo^{IV} are described. The compounds $MoO_3 \cdot nH_2O$ with n = 1 and 2 which are investigated in detail, are true oxide hydrates and not "molybdic acids". The second part, which covers most of the volume, deals with the oxomolybdenum species in aqueous solutions. There are cationic species with oxidation states II to V. Also mixed-valence species (Mo^{V}/Mo^{VI}) are known. - Literature closing date: mid-1985. 1987. 45 figs. XVII, 360 pages. Cloth
ISBN 3-540-93542-8

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.
1989. 79 figs. XIV, 283 pages. Cloth
ISBN 3-540-93564-9

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

Contains hydrated molybdenum-oxygen compounds which also contain other metals. Compounds with NH_4 or organically substituted N- or P-cations are treated in connection with the compounds with alkali metals. There is a comprehensive section on monomolybdates, isopolymolybdates, and peroxo-molybdates of the alkali (including NH_4, 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 Mo_2N and MoN. Among the fluorides MoF_n the compounds with n = 3 to 6 are stable but not those with n < 2. The pentafluoride MoF_5 is frequently contaminated with $MoOF_4$. An important and intensively examined oxide fluoride is, in addition to $Mo^{VI}OF_4$, $Mo^{VI}O_2F_2$. In the Mo-Cl series the structure of the well-investigated α-$MoCl_2$ is remarkable with the appearance of the Mo_6Cl_8 cluster as an important component. It is also found in $(H_3O)_2[(Mo_6Cl_8)Cl_6] \cdot 6H_2O$. - 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. 39 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: Mo_6S_8, Mo_2S_3, MoS_2, Mo_2S_5, and MoS_3. Above all, properties of MoS_2 were thoroughly investigated because of its numerous applications. Binary molybdenum sulfide ions comprise MoS_4^{2-}, MoS_9^{2-}, a few other mononuclear, several dinuclear $Mo_2S_n^{2-}$ (n = 6 to 12), and several polynuclear species up to $Mo_7S_8^{8+}$. - 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

Section 9: **Compounds with Se, Te, Po**

Covers the binary molybdenum selenide ions as well as the ternary and polynary compounds of Mo, Se, and additional elements. Included are the binary, ternary, and polynary compounds composed of Mo, Te, O, the halogens, S, and/or Se. - Literature closing date: mid of 1992. 1994. 57 figs. XVII, 165 pages. Cloth

ISBN 3-540-93691-2

Organomolybdenum Compounds

Part 5: **Mononuclear Compounds**

Describes ^{n}LMo compounds with n = 1 to 4. Additional CO groups may be present. Additional D ligands (D = amines, phosphanes, 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 ^{5}L ligand. Compounds described in the present volume can also contain one CO group and additional ^{1}L, ^{2}L, ^{3}L, or ^{4}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 ^{5}LMo compounds and their derivatives containing two CO groups but no additional ^{n}L ligands. Derivatives include ligands X (e.g. halogens) or ^{m}D (e.g. PR_3, ethers). Cations of this type with $[C_5H_5Mo(CO)_3]^-$ 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 $^{5}LMo(CO)_2$ compounds with ^{5}L = C_5H_5, indenyl, or substituted derivatives of C_5H_5. Additional ligands are of ^{1}L (allyl, aryl, carbene, isonitrile, carbyne, etc.), ^{2}L (olefine), ^{3}L, and ^{4}L (butadiene derivatives) type. ^{2}D, 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 $^{5}LMo(CO)_2$ compounds with heteronuclear compounds containing one or more additional transition metal fragments. Starts the treatment of compounds containing three CO groups with $[C_5H_5Mo(CO)_3]^+$, $[C_5H_5Mo(CO)_3]^-$ (incl. the appropriate salts), $[C_5H_5Mo(CO)_3]^{\bullet}$, and $C_5H_5Mo(CO)_3H$. - 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 $C_5H_5Mo(CO)_3$ fragment. Includes compounds of the types

$C_5H_5Mo(CO)_3X$, $C_5H_5Mo(CO)_3ER_n$, $[C_5H_5Mo(CO)_3{}^2D]^+$, $[C_5H_5Mo(CO)_3{}^2D]^{\bullet}$ and $[C_5H_5Mo(CO)_3EX_n]$-, as well as the heteronuclear compounds $C_5H_5Mo(CO)_3M(X,R)]_n$. E and M are a main group element and a transition metal, respectively. Empirical formula index. - 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 $C_5H_5Mo(CO)_3$ fragment by the treatment of $C_5H_5Mo(CO)_3{}^1$L and $[C_5H_5Mo(CO)_3{=}CRR']^+$ type compounds. Covers in the second part all compounds with a $^{5}LMo(CO)_3$ fragment with $^{5}L \neq C_5H_5$ and additional X, ^{n}D, ^{1}L, or $M(D,X,R)_n$ ligands (M = transition metal). 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 $[^{5}LMo(CO)_3{}^2L]+$,$[^{5}LMo(CO)_4]^+$, the great variety of mononuclear compounds with two ^{5}L ligands and additional X, ^{n}D, 'L, ^{2}L, and ^{3}L ligands, and compounds with four dienyl ligands. Contains an empirical formula index. - Literature closing date: March 1991. 1994. 92 figs. XII, 333 pages. Cloth

ISBN 3-540-93692-0

Part 13: **Mononuclear Compounds**

Starts the description of momonuclear organomolybdenum compounds with contain one ^{6}L ligand. Additional ^{n}D and up to three ^{1}L ligands may be present. ^{1}L ligands are alkyl, carbonyl, thiocarbonyl, isocyanide, 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**

HN_3, H_2NNH_2, and NH_3. Most of this volume is devoted to 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 N_2O, NO, N_2O_3, NO_2, and N_2O_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 nitrogen-hydrogen species NH, NH_2, NH_4, and NH_5, their ions, and some adducts (NH_3 and NH_4^+ are excluded). There is extensive information on NH and NH_2. - 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 N_2H_4). The major part deals with N_2H, N_2H_2, N_2H_3, N_3H and their corresponding ions. Several compounds with more than three nitrogen atoms are well known, e.g. N_4H_4, NH_4N_3, $N_2H_5N_3$, and N_4H_6. - Literature closing date: mid-1992. 1993. 2 figs. XIII, 188 pages. Cloth

ISBN 3-540-93672-6

Section 6: **Compounds with Oxygen (N_2O_5, NO_3, NO_3~)**

Deals with all known binary species formed between nitrogen and oxygen with the O:N ratio ≥ 2.5, i.e., N_2O_5, $N_2O_5^{2-}$, NO_3, $NO(O_2)$, NO_3^+, NO_3^+, NO_3", ONOO-, NO_3^{2}-, N_2O_6, $N_2O_6^{2-}$, $N_2O_7^{4-}$, NO_4, and NO_4^{n-}, n = 1,2,3. A wealth of chemical and physico-chemical data is reported on dinitrogen pentoxide, the NO_3 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, sulfite, sulfate, 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, sulfites, sulfate, thiosulfate, dithionite, tetrahydroborate, borates, carbonates, cyanide, silicates (water glass), phosphates, peroxo compounds, and H_2O_2 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

Section 3: **Compounds with Nitrogen to Carbon (Including Sodium Amidocarbonates and Excluding Sodium Halides)**

The Na-NH_3 system and specifically the blue solutions of elemental sodium in liquid ammonia, fall within the subject range of this volume. Describes the carbides and salts of carbonic, thiocarbonic, and carbamic acid. - Literature closing date: end of 1960. 1966. 117 figs. XL, 474 pages (in German). Cloth

ISBN 3-540-93131-7

Section 4: **Compounds from Sodium and Carbon (Sodium Cyanide) to Sodium and Bismuth**

Continues the description of compounds with carbon, and describes compounds with Si, P, As, Sb, and Bi. Includes glassy and alloy phases. - Literature closing date: end of 1960. 1967. 65 figs. XLI, 366 pages (in German).

ISBN 3-540-93132-5

Section 5: **Compounds of Na and the Halogens (Excluding Simple Halides). Na Systems with Various Anions from O to Bi. Na-Li Systems**

Covers three categories: (1) sodium hypochlorite, chlorite, chlorate, perchlorate, and the corresponding Br and I compounds; (2) anhydrous and aqueous systems of Na with two or more types of anions (mixed halides, however, are covered in Section 7); (3) the Na-Li and the Na-Li-NH_3 systems and anhydrous and aqueous Na-Li systems containing one or more types of anions. The anions in (2) and (3) are those which contain System-Number-elements 1 through 18. - Literature closing date: 1967. 1970. 285 figs. XXXIV, 508 pages (in German). Cloth

ISBN 3-540-93133-3

Section 6: **Halides (Preparation. Properties. Chemical Reactions)**

Anhydrous sodium halides. The text is organized by subject matter, rather then by compounds. Topics include preparation, changes of state, vapor phase, crystals, crystals with defects, contaminated crystals, fused halides, and reactions. - Literature closing date: mid-1971. 1973. 85 figs. XXII, 402 pages (in German). Cloth

ISBN 3-540-93134-1

Section 7: **Halides (Systems. Solutions)**

Sodium halide hydrates and solutions of sodium halides in water and in inorganic and organic solvents. Systems with two or more sodium halides are also covered, as are the sodium polyhalides. - Literature closing date: 1971. 1973. 143 figs. XXIV, 351 pages (in German). Cloth ISBN 3-540-93135-X

Formula and Subject Index

Covers the "Sodium" Main Volume and the 7 volumes of the supplement.
1973. VIII, 167 pages German-English subject index and empirical formula index.
Cloth ISBN 3-540-93136-8

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

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, Tl, 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, Tl, 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

Formula 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.

Ammonium – NH_4

Main Volume

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

Ammonium minerals. Properties, electrochemical behavior, and chemical reactions of the ammonium ion. Detection and determination. Compounds of ammonium with hydrogen, oxygen, nitrogen, and halogens. -
Literature closing date: February 1936.
1936, reprint 1969. 23 figs. XIV, 242 pages (in German). Cloth
ISBN 3-540-93011-6

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

Nickel - Ni

Main Volume

Part A I: **History. Occurrence. Preparation**

Occurrence, geochemistry, economic geography, and minerals receive special attention. Technology and preparation of nickel is emphasized; preparation, separation, and enrichment of nickel isotopes, toxicity of nickel and its compounds. - Literature closing date: end of 1963. 1967. 2 figs. XXXI, 641 pages (in German). Cloth
ISBN 3-540-93137-6

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**

Extensive coverage of the electrochemical behavior of alkaline storage batteries containing nickel hydroxide electrodes, and of the electrolytic deposition of nickel. - Literature closing date: end of 1966.
1968. 152 figs. XXV, 760 pages (in German). Cloth
ISBN 3-540-93139-2

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**

Compounds of nickel with noble gases, H, O, N, the halogens, S, Se, Te, and Po. - Literature closing date: end of 1962. 1966. 106 figs. XXXVII, 450 pages (in German). Cloth
ISBN 3-540-93141-4

Section 3: **Compounds** (Continued)

Nickel compounds with alkali metals including NH_4 and organic nitrogen bases, alkaline earth metals, boron-, carbon-, and nitrogen-group elements (except N), Zn, Cd, Hg, rare earth elements, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Th, and U. Includes carbides, carbonyls (including those with additional ligands), carbonates, nickel salts of organic acids, and cyanides. - Literature closing date: end of 1963. 1966. 104 figs. XLII, 478 pages (in German). Cloth
ISBN 3-540-93142-2

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

Section 2:

Completes coverage of nickel(II) complexes. Organic ligands are: aldehydes, ketones, aminoalcohols, aminophenols, aminoacids, 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(IV) 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

Part 1: **Mononuclear Compounds** (New Suppl. Ser. Vol. 16)
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 I. - Literature closing date: end of 1973. 1975. 44 figs. XIV, 419 pages (in German). Cloth

ISBN 3-540-93294-1

Part 2**: Mononuclear Compounds (Continued). Polynuclear Compounds** (New Suppl. Ser. Vol. 17)

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 l 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 Ni^{II} compounds of the type $(^1L)Ni(^2D)_2X$. $(^1L)Ni$ compounds containing η^2-bonded C_1 fragments such as CO_2 and CS_2, and related metallocyclic 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 $(^1L)_2Ni$, $(^1L\text{-}^1L)Ni$, $(^1L)_3Ni$, $(^1L)_4Ni$, $(^1L\text{-}^1L)_2Ni$, $(carbene)_n Ni$, 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, thiocarbonyl, or ylide as the only organic ligand. Additional X and ^nD ligands may be present. $Ni(CO)_4$ and more than 600 $(OC)_nNi(^2D)_{4-n}$ 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

Part A 1,1: **The Elements** (New Suppl. Ser. Vol. 7a)

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

Part A 1.11: **The Elements** (New Suppl. Ser. Vol. 7b) 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

Part A 2: **The Elements** (New Suppl. Ser. Vol. 8)

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

Part B 1: **The Metals** (New Suppl. Ser. Vol. 31)

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

Part B 2: **Binary Alloy Systems l** (New Suppl. Ser. Vol. 38)

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

Part B 3: **Binary Alloy Systems 2** (New Suppl. Ser. Vol. 39)

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

Part D 2: **Chemistry in Solution** (New Suppl. Ser. Vol. 21)

Continues coverage of transuranium element solution chemistry: Extraction of these elements by organophosphorus and organooxygen compounds and by other neutral extracting agents. Acidic extracting agents, especially the organophosphorus acids. Extraction by "onium" compounds. Synergistic and antagonistic effects in extraction. Ion exchange reactions. Solutions of transuranium elements in molten salts. - Literature closing date: end of 1970.
1975. 212 figs. XIV, 278 pages (51 pages in German, 80 pages in French). ISBN 3-540-93288-7

Index

The index includes the subjects and the substances appearing in Volumes Al I, Al II, A2, Bl, B2, B3, C, Dl, 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**

Fire and combustion processes. The phlogiston theory. Discovery of the element oxygen. The history of water is covered in a special section. - Literature closing date: end of 1939.
1943, reprint 1978. 9 figs. VI, 99 pages (in German).
Cloth ISBN 3-540-93184-8

Section 2: **Occurrence. Technology**

Occurrence of oxygen isotopes. Cosmic occurrence of oxygen. Free oxygen on earth. Combined oxygen in the solid crust. Terrestrial and cosmic occurrence of water. Industrial preparation of oxygen and of ozone. Water treatment including disinfection, removal of metals, softening, and desalination. Industrial preparation of hydrogen peroxide. Toxicity of oxygen, ozone, water, heavy water, and hydrogen peroxide. - Literature closing date: end of 1949.
1951, reprint 1966. 23 figs. XIII, 218 pages (in German).
Cloth ISBN 3-540-93185-6

Section 3: **Elemental Oxygen**

Laboratory preparation of oxygen and its isotopes, physical properties, and electrochemical behavior. Reactions in O_2-H_2 mixtures are treated in detail and include topics such as detonations and flames. - Literature closing date: end of 1949.
1958, reprint 1971. 100 figs. XXV, 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

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

The O_2-noble gas systems and short remarks on the O_2-H_2 system. Begins the description of water: preparation in pure form, purity testing, thermodynamic data, physical properties of the molecule, and chemical reactions. - Literature closing date: end of 1949. 1963. 104 figs. XXII, 548 pages (in German). Cloth
ISBN 3-540-93188-0

Section 6: **Ordinary Water (Electrochemical Behavior. Systems with Organic Solvents). Isotopic Waters. Water Ions**

Continues the description of water: electrochemical behavior; the H_2O-O_2 system, systems of water with hydrocarbons, benzene, alcohols, ethers, and aliphatic acids; enrichment, properties, and reactions of the various isotopic forms of water (D_2O, HDO, $H_2{}^{17}O$, $H_2{}^{18}O$, $D_2{}^{18}O$, T_2O, etc.); ions of water, especially H_3O^+ 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**

Preparation, properties, and reactions of H_2O_2. Properties, electrochemical behavior, stability, and chemical reactions of aqueous H_2O_2 solutions. Solutions of H_2O_2 in organic solvents. Deuterium peroxides. - Literature closing date: 1962. 1966. 82 figs. XXXII, 430 pages (in German). Cloth
ISBN 3-540-93190-2

Section 8: **The Radicals OH and HO_2. Hydrogen Ozonide HO_3. Higher Hydrogen Peroxides**. Formula Index and German-English Heading Index for Sections l to 8

Covers besides the title compounds the higher peroxides H_2O_3 and H_2O_4. 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 - 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

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

Organoosmium Compounds

Part A: Mononuclear Compounds

Section 1: **Mononuclear Compounds**

Describes a) ^{1}L compounds with alkyl, aryl, acyl, or alkinyl ligands except CO, b) $Os(CO)_1$ compounds which contain additional heteroatom-bonded ligands, such as H, halogens, O, S, N, or P donors, or boranes, c) $Os(CO)_1$ 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 $(^{1}L)_nOs$ compounds with those where ^{1}L=CO and n=2,3,4,5,6. Describes all known compounds which contain CS, CSe, CTe, and one to six CNR ligands for ^{1}L. Compounds with carbene and carbyne ^{1}L 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 $Os_3(CO)_{12}$, 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 triosmium 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 $Os_3(^{1}L)(CO)_n$ compounds with terminal ^{1}L = alkyl, CS, isocyanide, carbene. Other ^{1}L ligands are coordinated to Os_3 by one nonbridging Os-C bond and additional E → 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 μ_2- or μ_3-bridging carbon atom. Contains also heterometallic Os_3 carbonyl compounds which have additional, mostly bridging ^{1}L 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 tetraosmium 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
fin German). Cloth ISBN 3-540-93153-8

Part B: **Technology. Toxicity. The Element**

Technology of phosphorus and phosphoric acids. Toxicity of phosphorus and its compounds. The phosphorus atom, molecules, and molecular ions. The phase diagram with its phase modifications and transformations. Physical properties of the various states of aggregation and modifications. Electrochemical behavior, chemical reactions, and solubility in inorganic and organic solvents. Detection and determination. - Literature closing date: end of 1960. 1964. 32 figs. XXXV, 458 pages (in German). Cloth

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. LII, 642 pages (in German).

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 1: **Mononuclear Compounds with Hydrogen**

Covers the mononuclear, binary phosphorus-hydrogen compounds PH, PH_2, PH_3, PH_4, and PH_5 as well as the appropriate ions. There is extensive information on the chemical and physical properties of PH_3. - Literature closing date: May 1992. 1993. 13 figs. XVI, 326 pages. Cloth

ISBN 3-540-93680-7

Section 2: **Dinuclear Compounds with Hydrogen, Polyphosphanes 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., P_2N, PN_2, four-membered, i.e., P_3N, P_2N_2, PN_3, and five-membered, i.e., P_4N, P_3N_2, P_2N_3, PN_4, 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 X_2 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**

Contains history, occurrence and synthesis in nuclear reactions, properties of Pa isotopes, isolation and purification, atom and ions, analytical chemistry, uses, effect of radioactivity on the chemical behavior, health physics, and biology of protactinium. - Literature closing date: end of 1975. 1977. 108 figs. 9 color tables, 1 color picture, XV, 297 pages (202 pages in German).
Cloth

ISBN 3-540-93340-9

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 pneumatolytes, 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 H_2SO_4 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 electrolytic 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**

Double salts of lead and lithium, among others, are treated. - Literature closing date: 1968.
1970. 160 figs. XXXVIII, 406 pages (in German).
Cloth ISBN 3-540-93031 -0

Section 4: **Compounds and Alloys with Zn, Cd, Hg, Al, Ga, In, Tl, 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. XXVII, 639 pages (in German). Cloth

ISBN 3-540-93032-9

Organolead Compounds

Part 1: **Tetramethyllead**

This volume is devoted exclusively to tetramethyllead. 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. 4 figs. 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. 5 figs. XI, 273 pages. Cloth ISBN 3-540-93606-8

Part 3: **Tetraalkyllead, Tetraaryllead Compounds**

Describes PbR_4 compounds with four identical ligands except R = CH_3, C_2H_5. Symmetrical spiro compounds are included. Properties of tetrapropyl-, tetrabutyl-, and tetraphenyllead are known in more detail. Contains an empirical formula index. - Literature closing date: 1991. 1992. 5 figs. XIII, 246 pages. Cloth

ISBN 3-540-93658-0

Part 4: **R_3PbR' Compounds**

Describes the numerous compounds of the type R_3PbR' which make up the larger portion of known unsymmetrically substituted tetraorganyllead 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: **R_2PbR_2', $R_2PbR'R''$, $RPbR'R''R'''$, and $R_{4-n}PbH_n$ (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 $R_{4-n}PbH_n$ with n = 1,2,3. Empirical formula index. - Literature closing date: 1995. 1996. 5 figs. XIII, 191 pages. Cloth

ISBN 3-540-93748-X

Palladium - Pd

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-H_2 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 ISBN3-540-93152-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., oxo- or chloropalladates) 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

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 ^{192}Po to ^{218}Po), on production, isolation, and purification of the most important isotope ^{210}Po and of ^{208}Po, ^{209}Po, 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 3-540-93616-5

Platinum - Pt

Main Volume

Part A: **History. Occurrence. Formation and Preparation of the Platinum Metals (Ru, Rh, Pd, Os, Ir, and Pt). Alloys of the Platinum Metals**

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

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

Alloys of ruthenium from Ru and S to Ru and Au. Alloys of rhodium from Rh and S to Rh and Ru. Alloys of palladium from Pd and S to Pd and Rh. -
Literature closing date: mid-1948. 1949. 61 figs. XIII, 186 pages (in German). ISBN 3-540-93161-9

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)**

Covers experimental and theoretical aspects of the overvoltage phenomena on Pt electrodes. - Literature closing date: May 1939.
1939, reprint 1963. 48 figs. IX, 82 pages (in German),
Cloth ISBN 3-540-93165-1

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

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

Section 3: **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 com pounds. 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 3-540-93170-8

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 3-540-93528-2

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 3-540-93583-5

Radium - Ra

Main Volume

Includes history and occurrence of the element, recovery of radium compounds. Describes the element and its compounds with H, C, N, chalcogens, and halogens. Includes radium chromate, and alloys with Hg and Ag. Covers the radium isotopes. -
Literature closing date: end of 1927.
1928, reprint 1976. 4 figs. XIV, 80 pages (in German).
Cloth ISBN 3-540-93268-2

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 ^{226}Ra, 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^{2+}, 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

Rubidium - Rb

Main Volume

Covers the element and its compounds with H, alkali metals up to K (including NH_4), 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 3-540-93181-3

Rhenium - Re

Main Volume. Bound together with System No. 69 **Technetium**

Covers history, occurrence, recovery from ores, the element (formation, preparation, physical properties, electrochemical behavior, chemical reactions, and detection and determination), and the alloys and compounds. -
Literature closing date: end of 1939.
1941, reprint 1972. 12 figs. XIV, 154 pages (in German).
Cloth ISBN 3-540-93179-1

Organorhenium Compounds

Part 1: **Mononuclear Compounds 1**

Contains mononuclear compounds with the organic ligand bonded to the Re through one C (^{1}L 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

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 ^{2}L to ^{4}L 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 $^5LRe(CO)_n$ compounds with n = 0, 1 and those $^5LRe(CO)_2$ compounds which do not contain additional ^{m}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 compounds by coverage of compounds of the types $^{5}LRe(CO)2^{1}L$, $^{5}LRe(CO)_3$, $^{5}LRe(CNR)(CO)$ with $^{5}L = C_5H_5$, $C_5H_5Re^{n}L$ with n = 2 to 4, $(C_5H_5)_2Re$, ^{5}LRe where ^{5}L is a mono- up to penta-substituted cyclopentadienyl or a six-membered or larger ring, and ^{6}LRe. 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 $^{1}LRe_2$ compounds, ^{1}L = alkyl, aryl, and $(CO)_nRe_2$ type compounds, n = 1 to 10 (except $(CO)_{10}Re_2$ itself), which may contain additional X, ^{n}D, and bridging ligands. Contains an empirical formula index, a ligand formula index, and a transition metal cross reference. - Literature closing date: end of 1993. 1994. 171 figs. XII, 542 pages. Cloth

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 cross reference. - Literature closing date: end of 1995. 1?96. 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., $[RhX_2L_4]X$. - Literature closing date: mid-1938.
1938, reprint 1971. 5 figs. XX, 153 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. Emphasis is on the alloys and their magnetic and electric properties. - Literature closing date: 1988. 1991. 181 figs. XV, 275 pages. Cloth

ISBN 3-540-93639-4

Part B: **The Compounds**

Section 1: **Compounds**

Covers hydrides, oxides, and oxorhodates, followed by hydroxides, hydroxo and aquo complexes, nitrates and their complexes, halides and their complexes, followed by sulfides, sulfoxide and sulfito complexes, sulfates and sulfato complexes, selenides and tellurides. Borides, borane complexes, carbides, carbonato, cyano, fulminato, and thiocyanato complexes follow. Finally, silicides, phosphides, phosphite and phosphato complexes and arsenites are treated. Several complexes with anionic ligands such as Cl^-, Br^-, CN^-, and SCN^- are included. - Literature closing date: end of 1981. 1982. 47 figs. XVIII, 221 pages. Cloth

ISBN 3-540-93464-2

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. - Literature closing date: 1982. 1984. 44 figs. XVIII, 248 pages.
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., $[Ru(NH_3)_4Br_2]Br$ 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 3-540-93192-9

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 H_2S, SO_2, SO_3, and H_2SO_4. Other chapters cover colloidal sulfur and the toxicity of sulfur, hydrogen sulfide, sulfur dioxide, sulfuric acid, etc. -
Literature closing date: end of 1949.
1953, reprint 1969. 76 figs. XXIV, 450 pages (in German).
Cloth ISBN 3-540-93193-7

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

Covers the several modifications of sulfur. Reviews preparation in pure form, physical properties, electrochemical behavior (of elemental and ionic sulfur), and chemical reactions. Concludes with a discussion of solutions of sulfur in organic and non-aqueous inorganic solvents. -
Literature closing date: end of 1949.
1953, reprint 1974. 54 figs. XX, 252 pages (in German).
Cloth ISBN 3-540-93269-0

Part B: **The Compounds**

Section 1: **Hydrides and Oxides of Sulfur**

Hydrogen sulfide; the hydrogen polysulfides; reactions of sulfur with oxygen; the sulfur oxides. -
Literature closing date: end of 1949.
1953, reprint 1968. 45 figs. XXIX, 372 pages (in German).
Cloth ISBN 3-540-93194-5

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 figs. XLIV, 758 pages (in German). Cloth
ISBN 3-540-93195-3

Section 3: **Compounds (Continued)**

Reviews the solubility of SO_2 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 figs, and 9 fold-out charts, XLVI, 745 pages (in German). Cloth ISBN 3-540-93196-1

Supplement Volume

Section 1: **Thionyl Halides**

Describes SOF_2, $SOCl_2$, SOClF, $SOBr_2$, SOBrF, SOBrCl, and SOI_2. 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: SF_2, S_2F_2, S_XF_2, SF_4, SF_6, and S_2F_{10}. The chlorides are $SC1_2$, S_2C1_2, S_XC1_2, and $SC1_4$. There are only a few bromides - SBr_2, S_2Br_2, and S_xBr_2 - and even fewer iodides - S_2I_2 and, in solution, S_XI_2. All mixed sulfur halides are also described. - Literature closing date: end of 1976. 1978. 16 figs. 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, SO_2 and SO_3. Lower oxides such as SO and S_2O 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 figs. XXIV, 344 pages (in German). Cloth
ISBN 3-540-93408-1

Section 4a/b: **Sulfanes**

The first part, 4a, describes hydrogen sulfide. The second part, 4b, treats the higher sulfanes - H_2S_2, H_2S_3, H_2S_n - and the H-S radicals and ions. - Literature closing date: end of 1981. 1983. 89 figs. XXI, 500 pages. Cloth
ISBN 3-540-93476-6

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, $S_3N_3Cl_3O_3$. Six subsequent chapters cover the chain-forming S^{VI}-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 figs. 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 S_2N_2, $S_3N_2^+$, $S_3N_2C1^+$, S_4N_2, S3N3$^-$, S3N3Cl3, S4N3$^+$, S_4N_4, $S_4N_5^+$, $S_4N_5^-$, $S_5N_5^+$, S_5N_6. - Literature closing date: 1983. 1985. 79 figs. XIV, 333 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. 43 figs. XVII, 325 pages. Cloth
ISBN 3-540-93544-4

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

Cyclic S-N compounds with sulfur of formal oxidation number IV. Six- to nine-membered ring systems which contain C atoms, C and O atoms, or C and P atoms. Formula index and ring index for Parts 3 and 4. - Literature closing date: end of 1984.
1987. 36 figs. XVI, 272 pages. Cloth
ISBN 3-540-93553-3

Part 5: **Compounds with Sulfur of Oxidation Number IV** (Continued)

Describes the acyclic S^{IV}-N compounds. In particular the molecule SN, salts of SN^+, metal complexes of SN, the superconducting solid $(SN)_X$, the thiazylhalides XS≡N (with X = F, CI, Br), and metal complexes of thiazyl compounds. -
Literature closing date: 1988.
1990. 69 figs. XVI, 276 pages. Cloth
ISBN 3-540-93599-1

Part 6: **Compounds with Sulfur of Oxidation Number IV** (Continued)

Describes sulfur-nitrogen compounds with 2-coordinate sulfur and deals with sulfinyl imide, O=S=NH, the sulfinyl imide anion, O=S=N-, and the numerous sulfinyl imides with inorganic and organic substituents. In addition, thiosulfinyl imides S=S=NR and salts of the anions S_3N^- and S_4N^- are treated. - Literature closing date: 1988. 1990. 35 figs. XXI, 330 pages. Cloth
ISBN 3-540-93609-2

Part 7: **Compounds with Sulfur of Oxidation Number IV (Continued)**

Continuing the treatment of acyclic S^{IV}-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 S^{IV}-N compounds and describes classes with 3- and 4-coordinate sulfur like $X_2S=NR$ and $R_2NS(O)X$ (X = halogen, OR', NR'_2, etc.; R = organyl), as well as $(R_2N)_3S+$ salts, F_3SNR_2, and $F_2S(NR_2)_2$. Formula index for Parts 5 to 8. - Literature closing date: end of 1989. 1991. 17 figs. 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 S^{II}-N compounds. Cyclic S^{II}-N-X compounds (X = Se, Te, P, Si, B, and above all C) as well as S^{II}-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 figs. XXIV, 336 pages. Cloth

ISBN 3-540-93664-5

Part 10a: **Compounds with Sulfur of Oxidation Number II**

Describes acyclic S^{II}-N compounds, their derivatives, and ions: SNR, SNS, SNSR, SNS^+ salts, SNN, $SNNR_n$, $HSNH_2$, thioximes, thionitrous acid derivatives, sulfur amide halogenides, sulfur amide hydroxides, S-phosphorus substituted thiohydroxylamines, etc. - Literature closing date: 1991. 1994. 14 figs. XXIV, 321 pages. Cloth

ISBN 3-540-93701-3

Part 10b: **Compounds with Sulfur of Oxidation Number II**

Continues the description of acyclic S^{II}-N compounds with the class of sulfur diamide derivatives which has numerous examples. - Literature closing date: 1991. 1994. 11 figs. 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, $R'S_2NR^2R^3$; diamino-disulfanes, $R^1R^2NS_2NR^3R^4$; amino-polysulfanes, $R^1S_nNR^2R^3$; and diamino-disulfanes, $R'R^2NS_nNR^3R^4$; where $n \geq 3$ 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 figs. XXXIII, 362 pages. Cloth ISBN 3-540-93737-4

Antimony - Sb

Main Volume

Part A: **History. Occurrence. Preparation of Metal**

Section 1: **History. Occurrence**

Outlines the history of antimony and of its chemistry. Then describes extraterrestrial and terrestrial occurrence, and begins the description of the antimony minerals. -
Literature closing date: January 1940.
1942, reprint 1963. 1 fig. XI, 226 pages (in German).
Cloth ISBN 3-540-93013-2

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 figs. 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 figs. 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 figs. 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 figs. XXXVII, 68 pages (in German). Cloth

ISBN 3-540-93018-3

Organoantimony Compounds

Part 1: **Compounds of Trivalent Antimony with Three Sb-C Bonds**

Contains the organoantimony 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. Stibabenzene. Stibacarboranes**

Describes compounds of the type R_2SbX and $RSbX_2$, 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), stibabenzene, and stibacarboranes. Formula index. - Literature closing date: end of 1978. 1981. 3 figs. XI, 182 pages.
Cloth ISBN 3-540-93440-5

Part 3: **Compounds of Pentavalent Antimony with Six, Five, and Four Sb-C Bonds**

Presents Sb^{v} compounds of the types SbR_5 and SbR_4X, ions $Sb(C_6H_5)_6^-$, $SbR_4X_2^-$, and SbR_4, antimony ylides, and some binuclear 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_3SbX_2 and $R_3Sb{=}X$. The X atoms in R_3SbX_2 may be part of a ring system. In the case of bidentate X ligands like O^{2-}, S^{2-}, SO_4^-, CO_3^{3-}, and others, the compounds are placed with the mononuclear R_3SbX_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 $R_3Sb(X)Y$, $R_2R'SbX_2$, $R_2R'Sb(X)Y$, 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

Rare Earth Elements – Sc, Y, La-Lu

Main Volume

Part A: **History. Occurrence**

Section 1: **Introductory Review. History. Occurrence**

Following an introductory review, this volume covers history, as well as cosmic and terrestrial occurrence, including geochemical and crystallochemical fundamentals. The minerals are also covered, together with the economic geography of the most important deposits. - Literature closing date: 1938. 1938, reprint 1970. 7 figs. XI, 122 pages (in German). Cloth

ISBN 3-540-93199-6

Section 2: **Scandium: History. Occurrence**

The geochemical behavior of scandium differs considerably from that of the other rare earth elements. For this reason, only scandium is covered in this volume - its history, occurrence, geochemistry, and minerals. - Literature closing date: 1971. 1973. 5 figs. XIV, 181 pages (in German). Cloth

ISBN 3-540-93200-3

Section 3: **Y, La, and the Lanthanides: Cosmochemistry**

The spectral lines from yttrium, lanthanum, and the lanthanides in the sun and stars; the presence of these elements in meteorites, tektites, and lunar rocks. Emphasis is given to the fractionation of rare earth elements in meteorites and lunar rocks since such fractionation provides information on the formation and development of the solar system. - Literature closing date: October 1979. 1980. 14 figs. XIV, 180 pages (in German) Cloth.

ISBN 3-540-93410-3

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**

Begins 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

Section 6a: **Y, La, and the Lanthanides: Geochemistry. Sedimentary Cycle. Metamorphic Cycle**

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

Section 6b: Y, **La, and the Lanthanides: Geochemistry. Hydrosphere. Atmosphere. Cosmochemical and Geochemical Cycles. Balance**

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**

Minerals of the rare earth elements belonging to the classes of halogenides, oxides, hydroxides, sulfates, borates, carbonates, phosphates, arsenates, and vanadates. - Literature closing date: 1982. 1984. 13 figs. XV, 248 pages. Cloth

ISBN 3-540-93489-8

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-, triortho-, and diorthosilicates. More rare are the cyclo-, ino-, 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**

Crystallographic, mechanical, thermal, electrical, magnetic, and optical properties of the metals. - Literature closing date: end of 1973.
1974. 250 figs. XIV, 344 pages (in German). Cloth
ISBN 3-540-93278-X

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, Y, La to Sm)**

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 (nitrides, 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 hydroxides, fluoride nitrides, 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 1975. 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 Oxoacids of Chlorine, and Alkali Chlorometallates**

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 chlorometallates). 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 bromometallates), the rare earth metal iodides, basic iodides, iodates, periodates, and the alkali metal double iodides (alkali iodometallates). - 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 Thiometallates**

Covers the sulfides, oxide sulfides, and alkali metal thiometallates 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 Compounds**

Describes the rare earth metal sulfide halides, sulfites, sulfates, alkali metal double sulfates (alkali sulfatometallates), 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**

Contains comparative data for the rare earth element borides and sections for the individual Sc, Y, and La borides. - Literature closing date: 1988. 1990. 88 figs. XIV, 275 pages. Cloth

ISBN 3-540-93604-1

Section 1 lb: **Compounds with Boron**

Continues the individual descriptions of rare earth borides with those of Ce to Lu. The second part deals with alkali borates and hydrogen borates. - Literature closing date: 1989. 1991. 253 figs. XVIII, 496 pages. Cloth

ISBN 3-540-93620-3

Section 12a: **Compounds with Carbon**

Describes the carbides, fullerenes, graphite intercalation compounds, hydride carbides, oxide carbides, nitride carbides, carbide halides, and boride carbides of Sc, Y, La, and the rare earth elements. - Literature closing date: 1994. 1995. 96 figs. XX, 459 pages. Cloth

ISBN 3-540-93718-8

Section 12b: **Compounds with Carbon**

Describes carbonates including oxid- and hydroxidcarbonates alkali rare earth double carbonates, cyanides, cyanates, thiocyanates, alkali rare earth double thiocyanates, and selenocyanates. - Literature closing date: spring 1993. 1994. 41 figs. XVIII, 362 pages. Cloth

ISBN 3-540-93689-0

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-hydroxyquinolinates 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, amides, antipyrine, and cryptands. 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, sulfonamide, tri- and tetrasulfamidic acids, mercapto compounds, thiocarboxylic acids, dithio-carbamic acids, thiourea and derivatives, thiocarbamides, thiocarbazones, and semicarbazones, thioketones, S-heterocycles, dimethyl selenoxide, bis(trimethyl)-silylamides, phosphines, phosphine oxides, phosphinic and phosphonic acids and their esters, esters of phosphoric acid, amides of phosphinic and phosphoric acids, tri- and tetrametaphosphimic acids, thiophosphinic acids, esters of dithiophosphoric acids, arsines, arsine oxides, biologically important ligands). Formation and properties of MX_n 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 oxocarboxylic acids, sulfo acids, and the esters of these acids. -
Literature closing date: 1982.
1984. 45 figs. XIV, 385 pages. Cloth

ISBN 3-540-93497-9

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 heptamethylindenide. The volume is completed with an empirical formula index for the organometallic compounds. - Literature closing date: 1981.
1983. 49 figs. XII, 304 pages. Cloth

ISBN3-540-93491-X

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.
1993. 198 figs. XVI, 275 pages. Cloth ISBN 3-540-93663-7

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 1939.
1942, reprint 1970. 7 figs. XVII, 292 pages (in German).
Cloth ISBN 3-540-93197-X

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.
1950, reprint 1970. 106 figs. XIV, 122 pages (in German).
Cloth ISBN 3-540-93198-8

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.
1953, reprint 1974. 158 figs. XVIII, 184 pages (in German).
Cloth ISBN 3-540-93270-4

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.
1949, reprint 1974. 11 figs. XX, 195 pages (in German).
Cloth ISBN 3-540-93271-2

Supplement Volume

Part A: **The Element**

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

Industrial production of selenium, including recovery from scraps and waste. Uses of selenium. Laboratory preparation, including the preparation of particular modifications, single crystals, and thin films. Preparation of selenium isotopes. -
Literature closing date: end of 1977.
1979. 29 figs. XVIII, 278 pages (98 pages in German).
Cloth ISBN 3-540-93404-9

Section 2: **Atom. Molecule. Crystallographic Properties**

The mass, spin, and decay of the selenium nuclides ^{68}Se to ^{91}Se, 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.
1980. 49 figs. XVI, 252 pages (238 pages in German).
Cloth ISBN 3-540-93418-9

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: H_2Se, including molecular properties, optical spectra, and chemical behavior; selenium oxides and oxoacids and anions of the oxoacids; Se_4N_4 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 SeF_4 or SeF_6 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

Silicon - Si

Main Volume

Part A: History. Occurrence

Section 1: **History**

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

Part B: **The Element and Its Inorganic Compounds**

Covers laboratory and industrial preparation, uses, and physical and chemical properties of elemental silicon. Compounds described contain H, B, C (carbides, cyanides, cyanates, thiocyanates), N, chalcogens, halogens, and noble gases. Coverage of the inorganic compounds of silicon pays special attention to silicon dioxide. Properties and behavior of the glass electrode are covered in a separate chapter. -
Literature closing date: end of 1949.
1959, reprint 1970. 154 figs. LXV, 923 pages (in German). Cloth ISBN 3-540-93211-9

Supplement Volume

Part B: **The Compounds**

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

Opens with the system silicon-hydrogen; the SiH_n molecules and ions with n = 1 to 5 follow. The major parts of the volume deal with monosilane, SiH_4, with linear and branched Si_nH_{2n+2}, and with cyclic Si_nH_{2n} species. A discussion of siloxanes containing Si-H bonds, e.g., $H_3SiOSiH_3$ and siloxene, $(Si_6O_3)H_3$, constitutes the third main section of the volume. - Literature closing date: 1980. 1982. 22 figs. XII, 259 pages. Cloth
ISBN 3-540-93461-8

Section 2: **Properties of Crystalline Silicon Carbide. Diodes. Molecular Species in the Gas Phase. Amorphous Silicon-Carbon Alloys**

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

Section 3: **System Si-C. SiC: Preparation and Manufacturing Chemistry. Special Forms. Manufacture. Electrochemical Properties. Chemical Reactions. Applications. Ternary and Higher Systems with Si and C**

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

Section 4: **System Si-N. Binary and Ternary Silicon Nitrides. Silicon-Nitrogen Hydrogen Compounds. N-Substituted Silicon-Nitrogen Compounds**

The current volume describes the compounds of silicon with nitrogen. Si_3N_4 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 5bl: **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 5d1: **Silicon Nitride: Electrochemical Behavior, Colloidal Chemistry and Chemical Reactions**

Describes the electrochemical behavior and colloidal chemistry of Si_3N_4, its thermal decomposition, the effects of radiation on Si_3N_4 as well as the tribochemical reactions. The mayor part covers the chemical reactions of Si_3N_4 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 5d2: **Silicon Nitride: Chemical Reactions** (continued)

Describes the oxidation of silicon nitride ceramic systems in oxygen, air, and water, the reactions with nonmetallic elements, the etching by halogen-containing gases and plasmas, the corrosion in combustion gas systems, as well as the reaction with nonionic inorganic compounds, inorganic acids, alkali hydroxides, inorganic salts, organometallic and organic compounds. Index of reactants for volumes B5 d1 and d2. - Literature closing date: December 1992. 1995. 74 figs. XIII, 303 pages. Cloth
ISBN 3-540-93716-1

Section 5e: **Non-Electronic Applications of Silicon Nitride. SiN_x. SiN_x:H**

Describes in the first part the various applications and uses of Si_3N_4 in the broad area of engineering ceramics. The second and third parts describe the investigations on nonstoichiometric SiN_x and SiN_x:H alloys. -
Literature closing date: December 1992.
1994. 9 figs. XIV, 386 pages. Cloth
ISBN 3-540-93693-9

Section 7: **Binary Silicon-Fluorine Compounds**

Describes all known binary silicon-fluorine compounds and ions such as SiF, SiF_2, SiF_3, SiF_4, SiF_5^-, SiF_6^{2-}, and higher perfluorosilanes Si_nF_{2n+2} or Si_nF_{2n}. Emphasis is on the well-known physical and chemical properties of SiF_4 and on SiF_2 with its interesting chemistry. - Literature closing date: January 1992. 1992. 14 figs. XIX, 348 pages. Cloth
ISBN 3-540-93651-3

Section 8: **Ternary Silicon-Fluorine-Hydrogen Compounds**

Describes all known ternary silicon-fluorine-hydrogen compounds. SiH_3F, SiH_2F_2 $SiHF_3$, 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: November 1995. 1996. 16 figs. XIII, 212 pages. Cloth

ISBN 3-540-93728-5

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

Tin - Sn

Main Volume

Part A: **History. Occurrence**

Reviews the historical names and symbols for tin. Discusses the history of tin in various cultures - from antiquity, through the Middle Ages, to more recent times. Contains historical sections on tin ores and on methods of refining and subsequent treatment. The second part treats the cosmochemistry and geochemistry of tin, as well as its minerals and deposits. - Literature closing date: end of 1969. 1971. 32 figs. XIX, 451 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. 130 figs. XXV, 423 pages (in German). Cloth

ISBN 3-540-93066-3

Part C: **The Compounds**

Section 1: **Compounds with Hydrogen, Oxygen, Nitrogen, and the Halogens**

Inorganic systems and compounds of tin. Emphasis is given to the complex anions (e.g., $[SnX_n]^{(2-n)+}$), including those with mixed anionic ligands. - Literature closing date: end of 1970. 1972. 44 figs. XXXI, 503 pages (in German). Cloth

ISBN 3-540-93069-8

Section 2: **Compounds with S, Se, Te, Po, B, C, Si, P, As, Sb, and Bi**

Continues the description of tin compounds. - Literature closing date: end of 1972. 1975. 150 figs. XXIV, 300 pages (in German). Cloth

ISBN 3-540-93078-7

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 $Y_2[SnX_6]$ (X = F, C1; Y = O_2, NO, NO_2, $C1O_2$, $C1F_2$, 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, Tl, 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. XXII, 247 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 Sn^{II} complexes, those Sn^{IV} complexes bonded through oxygen to ligands, and some Sn^{IV} 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 Sn^{IV} 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 3-540-93357-3

Part D: **The Alloys**

Contains tin alloys with alkali and alkaline earth metals, Al, Ga, In, Tl, Ge, Sb, Bi, Zn, Cd, Hg, Ti, Zr, Hf, rare earth metals, and Th. A review chapter deals with the industrially important Sn alloys. - Literature closing date: end of 1972. 1974. 283 figs. XXVII, 468 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 SnR_4 (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

Part 2: **Tin Tetraorganyls R_3SnR'** (New Suppl. Ser. Vol. 29)

Continues the description of the mononuclear tin tetraorganyls with coverage of R_3SnR'-type compounds. - Literature closing date: end of 1973. 1975. 2 figs. XV, 480 pages (in German). Cloth

ISBN 3-540-93303-4

Part 3: **Tin Tetraorganyls $R_2SnR'_2$, $R_2SnR'R''$, $RR'SnR''R'''$, Heterocycles, and Spiranes** (New Suppl. Ser. Vol. 30)

Concludes coverage of the mononuclear tin tetraorganyls. - Literature closing date: end of 1973. 1976. XV, 164 pages (in German). Cloth

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

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 R_3SnCl, $R_2R'SnCl$, 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 R_2SnCl_2, $RR'SnCl_2$, $RSnCl_3$, R_2SnXCl, $RSnXCl_2$, and $RSnX_2Cl$. - 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, isocyanides, isothiocyanates, 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 R_3SnSR' 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 $R_2R'SnSR"$ 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 $R_2Sn(SR')_2$, $R_2Sn(SR')(SR")$, and $RR'Sn(SR")_2$, including heterocyclic species, and the monoorganotin species of types $RSn(SR')_3$ and $RSn(SR')_2(SR")$. Other compounds treated in this volume are of the types $R_2SnX(SR')$, $RR'SnX(SR")$ $RSnX(SR')_2$, $RSnX_2(SR')$, and $RSnXY(SR')$. 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**

Begins the treatment of mononuclear R_3Sn-OR' compounds with the trimethyltin- and triethyltin-oxygen compounds. - Literature closing date: 1982. 1984. 17 figs. X, 292 pages. Cloth

ISBN 3-540-93501-0

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., $(C_2H_7)_3SnOR'$ and $(C_4H_9)_3SnOR'$ -
Literature closing date: 1982.
1985. 1 fig. X, 264 pages. Cloth

ISBN 3-540-93521-5

Part 13: **Other R_3Sn-Oxygen Compounds, $R_2R'Sn$- and RR'R"Sn-Oxygen Compounds**

Continues the description of the mononuclear organotin compounds with tin-oxygen bonds. It contains all R_3Sn-oxygen compounds with R other than methyl, ethyl, propyl, and butyl as well as $R_2R'Sn$- 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 mononuclear organotin-oxygen compounds containing R_2Sn 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 R_2Sn-oxygen compounds where R is exclusively *n*-, *i*-, and *t*-butyl. Large parts of the volume deal with dibutyltin dilaurate 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: **Diorganyltin-Oxygen Compounds with R_2Sn, RR'Sn, or R-Sn Units and with Identical or Different Oxygen-Bonded Groups**

Continues the description of the mononuclear R_2Sn-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 $R_2Sn(OR')OR"$ or $RR'Sn(OR")OR'"$. - 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 $RSn(OR')_2OR"$; $R_2Sn(X)OR'$, $RSnX(OR')_2$, and $RSnX_2(OR')$**

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')OR", compounds of the type $R_2SnX(OR')$, $RSnX(OR')_2$ and $RSnX_2(OR')$ are treated with X = H, halogen, or pseudohalogen. Contains also a ligand index. - Literature closing date: 1987. 1989. 6 figs. XIV, 245 pages. Cloth

ISBN 3-540-93596-7

Part 18: **Organotin-Nitrogen Compounds. R_3-Sn Nitrogen Compounds with R = Methyl, Ethyl, Propyl, and Butyl**

Treats triorganotin-nitrogen compounds containing only R_3Sn 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, Tl; Mg, Ca,; Li, Na, K, or Cs. R_3SnM 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

Part 23: **Tin-Centered Radicals, Tin (II) Compounds, Compounds with Tin - Element Double Bonds, Tin (II) Complexes with Aromatic Systems. Stannacarboranes, and Other Organotin Compounds**

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_3Sn-G-SnR_3 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 R_3Sn-G-SnR_3 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 CH_3 (the majority of compounds), C_2H_5, C_3H_7, and C_4H_9. A few species with other alkyl, cycloalkyl, or vinyl groups for R are known. Transition metal cross reference. - Literature closing date: end of 1994.
1996. 11 figs. XIV, 292 pages. Cloth

ISBN 3-540-93738-2

Strontium - Sr

Main Volume

Covers the element and its compounds with H, alkali and alkaline earth metals up to.Ca, B, C, Si, nitrogen-group elements, chalcogens, and halogens. Includes a chapter on manufacture of strontium compounds from their raw materials. - Literature closing date: July 1931.
1931, reprint 1974. 26 figs. XXXI, 239 pages (in German). Cloth

ISBN 3-540-93256-9

Supplement Volume

Describes history, cosmic occurrence, geochemistry, minerals, and commercial preparation, and updates the coverage of the element and its compounds with H, alkali and alkaline earth metals up to Ca, B, C, Si, nitrogen-group elements, chalcogens, and halogens. - Literature closing date: end of 1949. 1960. 39 figs. XXXVI, 306 pages (in German). Cloth

ISBN 3-540-93217-8

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 3-540-93218-6

Section 2: **The Element**

Isotopes, atoms, atomic ions, as well as crystallographic, mechanical, thermal, electrical, magnetic, and optical properties of the element. The final chapters deal with electrochemical behavior, chemical reactions, and analysis. - Literature closing date: end of 1965. 1969. 90 figs. XIV, 298 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**

Tantalum compounds and systems with noble gases, H, O, N, halogens, S, Se, Te, Po, B, C, Si, P, As, Sb, and Bi. - Literature closing date: end of 1967.
1970. 76 figs. XXVI, 275 pages (in German). Cloth

ISBN 3-540-93220-8

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, and As. The concluding chapters cover tantalum salts of organic acids, compounds with organic bases, carbonyls, organotantalum compounds, and the complex compounds with organic ligands. - Literature closing date: end of 1967. 1971. 185 figs. XXXII, 383 pages (in German). Cloth

ISBN 3-540-93221-6

Combined Formula and Heading Index for System Nos. 48,49, and 50, as well as for New Suppl. Ser. Vol. 2

Contains English and German subject indexes and a formula index for the "Niobium" Volumes A and Bl to B4, the "Tantalum" Volumes Al, A2, Bl, and B2, the "Vanadium" Volumes Al, A2, Bl, and B2, and the "Organovanadium Compounds" Volume (New Suppl. Ser. Vol. 2). 1973. X, 352 pages (63 pages in German). Cloth

ISBN 3-540-93222-4

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 1939. 1941, reprint 1972. VII, 10 pages (in German). 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.

Section 2: **Physical Properties. Electrochemical Behavior. Chemical Reactions**

Short section on crystallization. The electrical and optical properties are presented in a compressed form because of the vast amount of material. In these chapters the Se-Te alloys are treated along with pure Te. Much is also available on the electrochemistry, so important for the preparation of pure tellurium. - Literature closing date: end of 1981. 1983. 144 figs. XVI, 395 pages. Cloth ISBN 3-540-93470-7

Part B: **The Compounds**

Section 1: **Compounds with Hydrogen, Oxygen, and Nitrogen**

The treatment of the tellurium-containing acids also includes their alkali salts: the alkali tellurides, alkali tellurates(IV), alkali tellurates(VI), etc. Only a small number of nitrogen compounds are known; the nitrides are exceptionally explosive. - Literature closing date: end of 1973. 1976. 60 figs. XX, 153 pages (in German). Cloth

ISBN 3-540-93314-X

Section 2: **Compounds with Fluorine and Chlorine**

Covers the binary fluorides TeF_4 and TeF_6; the ions TeF_5^-, TeF_7^-, and TeF_8^{2-}; the simple and polymeric complex salts; and the fluoroxo- and fluorohydroxotellurates(IV). Includes short sections on subchlorides, $TeCl_2$, and trichlorotellurates(II) and longer sections on the reactive $TeCl_4$, the complex ions $TeCl_n^{(4-n)+}$, and the alkali hexachlorotellurates(IV). - Literature closing date: end of 1973.
1977. 28 figs. XVIII, 152 pages (in German). Cloth
ISBN 3-540-93352-2

Section 3: **Compounds with Bromine, Iodine, Sulfur, and Selenium. Complexes**

Tellurium bromides and iodides and the bromo- and iodotellurates. The oxidation state Te^{IV} is the most important. The alkali metal salts are discussed with the corresponding acid or anion. Sulfur-tellurium compounds, selenium-tellurium compounds, and the tellurium complexes with neutral or chelate ligands are described. - Literature closing date: end of 1973.
1978. 70 figs. XXII, 183 pages (in German). Cloth
ISBN 3-540-93358-1

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 3-540-93227-5

Supplement Volume

Part A: **The Element Section la: 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, i.e., its mode of occurrence, distribution between minerals, diadochy 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 lb: **Minerals (Silicates). Deposits. Mineral Index**

Completes the description of thorium minerals with the silicates, their occurrence, chemistry, crystal form and structure, physical properties, and chemical behavior. There is an overview on deposits of thorium. - Literature closing date: 1987. 1991. 20 figs. XVI, 440 pages. Cloth

ISBN 3-540-93627-0

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 3-540-93532-0

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 ThN, 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

~^N 3-540-93598-3

Part B: **The Alloys**

Section 2**: Alloys of Thorium with Metals of Main Groups I to IV**

Out of the alloys and intermetallic compounds described, the Th-Mg and Th-Al systems have attained technological interest and physical properties of $ThBe_{13}$ have been studied in detail. Interest in ternary alloys with Th, a metal of main groups I to IV, and a third metal has focused on Th-Mg, Th-Al, and Th-Sn related systems. - Literature closing date: 1991. 1992. 97 figs. XVI, 189 pages. Cloth

ISBN 3-540-93656-4

Part C: **The Compounds**

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

The only noble gas compound is $K_4Th(XeO_6)_2 \cdot 4\ H_2O$. Binary hydrides ThH_2 and Th_4H_{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, CI, 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 $ThC_{1\pm x}$ 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 $(NH_4)_2[Th(CH_3COO)_6]$ or carbonato oxalate thorates like $(CN_3H_6)_3(NH_4)[Th(C_2O_4)(CO_3)_3] \cdot 3H_2O$ (CN_3H_6 = guanidinium) are treated. - Literature closing date: mid-1986. 1988. 12 figs. XIV, 162 pages. Cloth

ISBN 3-540-93570-3

Section 8: **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 Th^{4+} - 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, pseudohalogenide, 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^{IV} complexes. - Literature closing date: 1983. 1985. 40 figs. XVIII, 322 pages. Cloth

ISBN 3-540-93515-0

Titanium - Ti

Main Volume

History, occurrence, and minerals. Industrial preparation of titanium dioxide. Preparation, physical properties, electrochemical behavior, and chemical reactions of the metal. Physiological activity. Alloys of titanium with Be, Zn, Cd, Hg, Ga, In, and La. Compounds up to those with the rare earth elements. General reactions of titanium salts. - Literature closing date: end of 1949. 1951, reprint 1971. 100 figs. LI, 481 pages (in German). Cloth

ISBN 3-540-93228-3

Organotitanium Compounds

Part 1: **Mononuclear Compounds l** (New Suppl. Ser. Vol. 40)

Describes mononuclear organotitanium compounds with ^{1}L to ^{5}L 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 ^{5}L (e.g. cyclopentadienyl) ligands; complete coverage of the Ti^{I} through Ti^{III} compounds, and partial coverage of the Ti^{IV} compounds. The key compound from which the majority of the compounds in this volume were prepared was $(\pi\text{-}C_5H_5)_2TiCl2$. - 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 ^{5}L groups, followed by complexes containing ^{X}L 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 $Ti(C_5H_5)_2$ 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

Thallium - Tl

Main Volume

Section 1: **History. Occurrence. The Element**

Following a short section dealing with history, this volume covers cosmic and terrestrial occurrence, formation and preparation of the metal, and recovery of Tl compounds from intermediates. Later chapters cover the physical properties, electrochemical behavior, and chemical reactions of the metal, physiological activity of the metal and its compounds, and analysis. - Literature closing date: July 1939.
1939, reprint 1962. 6 figs. XVII, 186 pages (in German).
Cloth ISBN 3-540-93224-0

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.
1940, reprint 1962. 21 figs. XVIII, 152 pages (in German).
Cloth ISBN 3-540-93225-9

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" [sic, C2 ?], thorium C", and actinium C") are described in a separate section. - Literature closing date: end of 1939. 1940, reprint 1962. 16 figs. XXVI, 189 pages (in German).
Cloth ISBN 3-540-93226-7

Uranium - U

Main Volume
(With an Appendix Covering the Transuranium Elements)

History, cosmic and terrestrial occurrence, minerals, recovery from ores. The element: preparation, physical and chemical properties, alloys. The composition, preparation, and proper ties of uranium compounds occupy the bulk of the volume. Compounds include all elements except Mn to Cu, Ag, Au, platinum group elements, Tc, Re, and transuranium elements. Concludes with a discussion of isotopes of uranium and an appendix on early work on transuranium elements. - Literature closing date: end of 1935.
1936, reprint 1972. 4 figs. XXVII, 279 pages (in German).
Cloth ISBN 3-540-93231 -3

Supplement Volume

Part A: **The Element**

Section 1: **Uranium Deposits**

Describes the geology of uranium deposits and ore-forming processes. World-wide coverage, except for COMECON countries, of individual deposits of commercial interest, with numerous maps and tables. - Literature closing date: October 1979. 1979. 74 figs. XVIII, 280 pages (in German).
ISBN 3-540-93403-0

Section 2: **Isotopes**

History of uranium. Production and separation of technologically important isotopes. Nuclear properties, with detailed discussions of ^{232}U, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{237}U. Current commercial isotope production and separation processes and potential alternative future procedures. - Literature closing date: mid-1978.
1980. 156 figs. XVI, 338 pages (129 pages in German).
Cloth ISBN 3-540-93423-5

Section 3: **Technology. Use**

Detailed description of processes for extraction of uranium from ores and sea water. Technical production of important compounds, particularly UO_2 and UF_6. Production, properties, and uses of various forms of uranium as nuclear fuels: metal, alloys, oxides, carbides, nitrides, combined ceramics, other compounds, dispersion fuels, liquids and gases. Other uses of uranium are also described. - Literature closing date: mid-1979.
1981. 82 figs. XXVII, 297 pages (in German). Cloth
ISBN 3-540-93429-4

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_2/ThO_2 from high-temperature reactors. Processing of UO_2/PuO_2 wastes is described in "Transuranium Elements" Part A 1, II. - Literature closing date: mid-1980. 1982. 173 figs. XIII, 359 pages. Cloth
ISBN 3-540-93453-7

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. 47 figs. XIII, 269 pages. Cloth
ISBN 3-540-93459-6

Section 6: **General Properties. Criticality**

Opens with a chapter on general properties of uranium and uranium ions. The properties of the UO_2^{2+} ion are presented in a separate chapter. The chapter "Photochemistry of Uranium" emphasizes the behavior of the UO_2^{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
ISBN 3-540-93471-5

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
ISBN 3-540-93455-3

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_{13} plays an important role. Its physical properties were therefore extensively studied. Cermets 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 figs. XXII, 333 pages. Cloth
ISBN 3-540-93591-6

Section 3: **Alloys of Uranium with Transition Metals of Groups I B to IV B**

Covers binary alloys and intermetallic compounds U-M, where M = Cu, Ag, Au; Zn, Cd, Hg; Sc, Y, lanthanides; Ti, Zr, Hf, as well as related ternary and polynary alloys containing other transition elements. - Literature closing date: 1993. 1994. 175 figs. XVII, 304 pages. Cloth ISBN 3-540-93702-1

Section 4: **Alloys of Uranium with Transition Metals of Groups VB to VII B**

Covers binary alloys and intermetallic compounds U-M, where M = V, Nb, Ta; Cr, Mo, W; Mn, Tc, Re, as well as related ternary and quaternary systems containing another transition metal of these groups or of group VIII (Fe to Pt). - Literature closing date: 1994.
1995. 99 figs. XV, 246 pages. Cloth
ISBN 3-540-93720-X

Part C: **The Compounds**

Section 1: Compounds with Noble Gases and Hydrogen. The Uranium-Oxygen System

U-noble gas systems. The U-H system, UH_3, compounds with deuterium and tritium, ternary and polynary hydrides. The U-O system, UO, U_4O_9, U_3O_7 phases,$UO_{2.40}$ to $UO_{2.44}$, U_2O_5, phases between U_2O_5 and U_3O_8. - Literature closing date: end of 1975.
1977. 85 figs. XX, 206 pages (in German). Cloth
ISBN 3-540-93344-1

Section 2: **Oxides U_3O_8 and UO_3. Hydroxides, Oxide Hydrates, and Peroxides**

U_3O_8 is formed by thermal decomposition of many U compounds. UO_3 exists in at least six modifications with different colors and stabilities. Known hydrates or hydroxides include $2UO_3 \cdot H_2O$, $UO_3 \cdot H_2O$, $UO_3 \cdot 2H_2O$, and $UO_2 \cdot xH_2O$. Peroxidic compounds include both anhydrous and hydrated U_2O_7, $UO_4 \cdot 2H_2O$, and $UO_2 \cdot 4H_2O$. - Literature closing date: mid-1976. 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, UO_2, Preparation and Crystallographic Properties**

Deals with the preparation and production of uranium dioxide, UO_2, as well as its crystallographic properties. UO_2 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, UO_2, Physical Properties. Electrochemical Behavior**

Physical properties of UO_2. 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-X

Section 6: **Uranium Dioxide: Chemical Behavior**

Numerous reactions of UO_2 have been extensively studied because of the extraordinary importance of UO_2 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 nitrates. - 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. UF_6, the only readily volatile compound of uranium, is of dominant importance in separation of the isotopes. Its physical properties have been thoroughly investigated. UF_4 is an intermediate product in the production of UF_6 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, U_2S_3, U_3S_5, US_2, and U_2S_5, 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 (U_2N_2S). 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 sulfito complexes as well as the sulfate and sulfate 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 USe, 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 12: **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 $(U_{0.80}Pu_{0.20})C$ are of special importance due to their potential as fuel for advanced "Fast Breeder Reactors", the dicarbide UC_2 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 13: **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 H_2CO_3, HCN, HSCN, and HOCN. 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, 319 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 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 UO_2^{2+}, 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 El 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 V_2O_5 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. XXVII, 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 V_2O_5), as well as the compounds with elements N, F, CI, Br, I, S, Se, Te, Po, B, C, Si, P, As, Sb, and Bi. Carbon compounds include carbonyls, carbides, carbonates, formates, acetates, oxalates, tartrates, cyanides, and thiocyanates. - Literature closing date: end of 1963.
1967. 56 figs. 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 NH_4 and organic bases), alkaline earth metals, elements Al, Ga, In, Tl, 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. 110 figs. XXXIV, 471 pages (in German). Cloth
ISBN 3-540-93235-6

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

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, Th, Sn, Pb, V, Ta, Cr, and Mo. Compounds include all elements except Mn to Cu, Ag, Au, platinum group elements, Tc, 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: **Physical 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 voltametric 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

Section 5b: **Metal. Chemical Reactions with Nonmetals Nitrogen to Arsenic**

Describes the chemical behavior of W towards N, F, CI, Br, I, S, Se, Te, Po, B, C, Si, P, and As. Chemical and transport processes in tungsten-halogen lamps are described comprehensively. W-C and W-Si systems are also of practical importance. - Literature closing date: mid-1991. 1993. 129 figs. XIV, 196 pages. Cloth

ISBN 3-540-93676-9

Section 6a: **Metal. Chemical Reactions with Metals Antimony to Barium**

Describes the interactions and chemical reactions of the metal with Sb, Bi, alkali and alkaline earth metals. Surface processes in Cs-on-W and Ba-on-W are treated in much detail because of the many technical and laboratory appliances. -
Literature closing date: end of 1988.
1991. 159 figs. XX, 426 pages. Cloth

ISBN 3-540-93634-3

Section 6b: **Chemical Reactions with Metals**

Continues the description of the chemical reactions of tungsten, covering the reactions with the elements zinc to actinides (Gmelin System Numbers 32 to 71). The compilation also includes phase diagrams and surface processes. - Literature closing date: 1986. 1988. 89 figs. XIX, 338 pages. Cloth

ISBN 3-540-93562-2

Section 7: **Metal. Chemical Reactions with Inorganic and Organic Compounds**

Covers the chemical reactions of tungsten with inorganic and organic compounds. Of particular interest are the systems W-H_2O, W-NH_3, W-nitrogen oxides, W-hydrogen halides, W-CO, and W-CO_2. These in part are of practical importance in high vacuum technology and incandescent lamp fabrication and in part have been used as models to gain a fundamental understanding of surface reactions and catalysis problems, tungsten being a refractory metal which can very easily be obtained with a surface of controlled purity. - Literature closing date: 1985. 1987. 37 figs. XXV, 410 pages. Cloth

ISBN 3-540-93541-X

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 WO_3 has been studied most because of its many modifications and its use in producing the metal. The other major oxide is the stoichiometric WO_2. Several short chapters treat the gaseous tungsten oxide ions, the solid solution of oxygen in tungsten, the lower oxides W_3O and WO, and the series of oxides intermediate between WO_2 and WO_3. - Literature closing date: end of 1977. 1979. 60 figs. XVIII, 225 pages (in German). Cloth

ISBN 3-540-93385-9

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 3-540-93402-2

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_xWO_3 and there are several types of alkaline earth tungstates(VI): M_3WO_6, M_2WO_5, $M_3W_2O_9$, and MWO_4. 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 5: **Compounds of Tungsten with Oxygen and Group III A and III B Metals**

Concludes the treatment of the anhydrous tungstates. Describes those compounds with the second metal being Al, Ga, In, Tl, Sc, Y, La-Lu. - Literature closing date: 1981. 1984. 100 figs. XVI, 306 pages. Cloth

ISBN 3-540-93492-8

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

Contains the anhydrous tungstates with metals of 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"

Zinc - Zn

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 NH_4), 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

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 NH_4), 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. Organohafnium Compounds

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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.
Organohafnium 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.

Volume I: Ac-Au. 1975. XII, 253 pages.
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Formula Index, Second Supplement for 1980-1987

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