Heraeus

Chemical Products

Precious Metal Compounds and Homogeneous Catalysts

Heraeus – Your Partner for High-Quality Precious Metal Compounds and Homogeneous Catalysts

W. C. Heraeus GmbH has more than 150 years experience in the handling of precious metals. From founding the company by Wilhelm Carl Heraeus in 1851, mechanical and chemical processing as well as the recovery of precious metals have been the core business of our family-owned firm. Now as ever, Heraeus' precious metal chemicals are used in a multitude of key technologies all over the world.

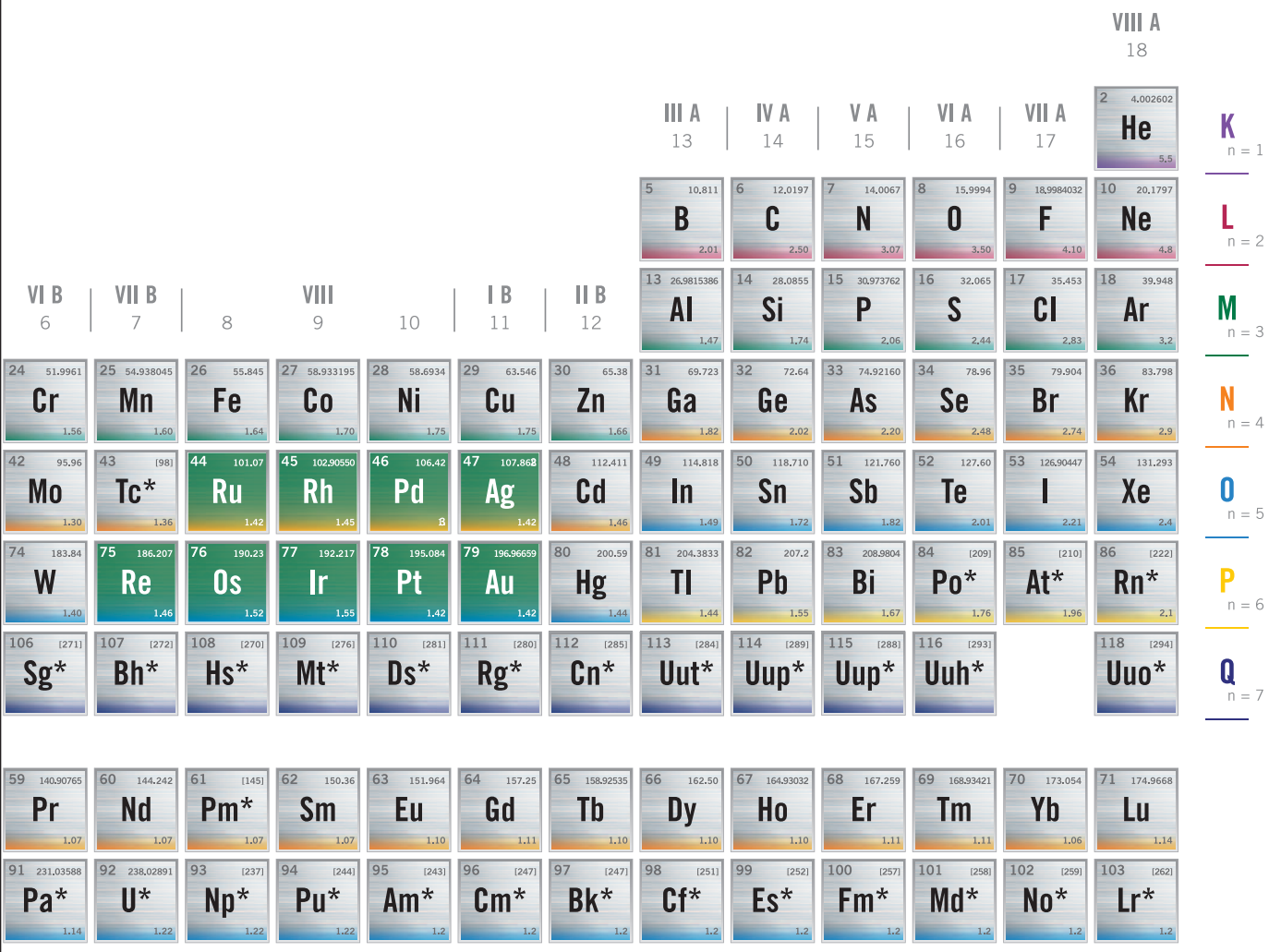
Whether in the production, R&D or analytical departments of the chemical, pharmaceutical, automotive, plating and electronic industries, – Heraeus' precious metal chemicals enjoy unanimous level of acceptance.

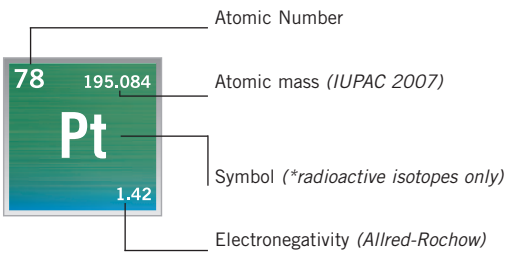
Besides an extensive number of inorganics and their solutions, we also synthesize large-scale organometallics and homogeneous catalysts that the markets require commercially.

Heraeus' close relationship to customers especially in the fields of petrochemistry, electronics and the anode industries has been growing continuously. This has led us to extend our product range to include selected non-precious metal compounds. So, today rhenium and its compounds are a regular part of Heraeus' total competence.

Abbreviation	Formula	Meaning
$acac^-$	$C_5H_7O_2^-$	acetylacetonate(1-) [= pentane-2,4-dionate(1-)]
cod	C_8H_{12}	cycloocta-1,5-diene
Cp^{*-}	$C_{10}H_{15}^-$	pentamethylcyclopentadienyl(1-)
dba	$C_{17}H_{14}O$	dibenzylideneacetone [= 1,5-diphenylpenta-1,4-diene-3-one]
dppe	$C_{26}H_{24}P_2$	1,2-bis(diphenylphosphano)ethane [= ethane-1,2-diylbis(diphenylphosphane)]
dppf	$C_{34}H_{28}FeP_2$	1,1'-ferrocenylbis(diphenylphosphane)
dppp	$C_{27}H_{26}P_2$	1,3-bis(diphenylphosphano)propane [= propane-1,3-diylbis(diphenylphosphane)]
en	$C_2H_8N_2$	ethylenediamine [= ethane-1,2-diamine]
Et	C_2H_5	ethyl
Me	CH_3	methyl
nbd	C_7H_8	norborna-2,5-diene [= bicyclo(2.2.1)hepta-2,5-diene]
OAc^-	$C_2H_3O_2^-$	acetate(1-)
Ph	C_6H_5	phenyl

a.c. relating to anhydrous compound


VIII A
18
III A
13
IV A
14
V A
15
VI A
16
VII A
17
2 4.002602 He 5.5
5 10.811 B 2.01
6 12.0197 C 2.50
7 14.0067 N 3.07
8 15.9994 O 3.50
9 18.9984032 F 4.10
10 20.1797 Ne 4.8
13 26.9815386 Al 1.47
14 28.0855 Si 1.74
15 30.973762 P 2.06
16 32.065 S 2.44
17 35.453 Cl 2.83
18 39.948 Ar 3.2
VI B
6
VII B
7
8
VIII
9
10
I B
11
II B
12
24 51.9961 Cr 1.56
25 54.938045 Mn 1.60
26 55.845 Fe 1.64
27 58.933195 Co 1.70
28 58.6934 Ni 1.75
29 63.546 Cu 1.75
30 65.38 Zn 1.66
31 69.723 Ga 1.82
32 72.64 Ge 2.02
33 74.92160 As 2.20
34 78.96 Se 2.48
35 79.904 Br 2.74
36 83.798 Kr 2.9
42 95.96 Mo 1.30
43 [98] Tc* 1.36
44 101.07 Ru 1.42
45 102.90550 Rh 1.45
46 106.42 Pd 8
47 107.868 Ag 1.42
48 112.411 Cd 1.46
49 114.818 In 1.49
50 118.710 Sn 1.72
51 121.760 Sb 1.82
52 127.60 Te 2.01
53 126.90447 I 2.21
54 131.293 Xe 2.4
74 183.84 W 1.40
75 186.207 Re 1.46
76 190.23 Os 1.52
77 192.217 Ir 1.55
78 195.084 Pt 1.42
79 196.96659 Au 1.42
80 200.59 Hg 1.44
81 204.3833 Tl 1.44
82 207.2 Pb 1.55
83 208.9804 Bi 1.67
84 [209] Po* 1.76
85 [210] At* 1.96
86 [222] Rn* 2.1
106 [271] Sg*
107 [272] Bh*
108 [270] Hs*
109 [276] Mt*
110 [281] Ds*
111 [280] Rg*
112 [285] Cn*
113 [284] Uut*
114 [289] Uup*
115 [288] Uup*
116 [293] Uuh*
118 [294] Uuo*
K n = 1
L n = 2
M n = 3
N n = 4
O n = 5
P n = 6
Q n = 7
59 140.90765 Pr 1.07
60 144.242 Nd 1.07
61 [145] Pm* 1.07
62 150.36 Sm 1.07
63 151.964 Eu 1.10
64 157.25 Gd 1.11
65 158.92535 Tb 1.10
66 162.50 Dy 1.10
67 164.93032 Ho 1.10
68 167.259 Er 1.11
69 168.93421 Tm 1.11
70 173.054 Yb 1.06
71 174.9668 Lu 1.14
91 231.03588 Pa* 1.14
92 238.02891 U* 1.22
93 [237] Np* 1.22
94 [244] Pu* 1.22
95 [243] Am* 1.2
96 [247] Cm* 1.2
97 [247] Bk* 1.2
98 [251] Cf* 1.2
99 [252] Es* 1.2
100 [257] Fm* 1.2
101 [258] Md* 1.2
102 [259] No* 1.2
103 [262] Lr* 1.2


78
195.084
Pt
1.42
Atomic Number
Atomic mass (IUPAC 2007)
Symbol (*radioactive isotopes only)
Electronegativity (Allred-Rochow)

Chemical Products – Core Competence of Heraeus

We are able to adjust packaging to our customers' requirements. The complete handling of our products, which are almost entirely "hazardous" goods, is done in strict adherence to the ruling safety regulations from the time of production until delivery at our customer's premises.

All over the world we are in close touch with our clients. A tightly knit, global sales network as well as the local production sites in the fast growing industrial centers provide short distances to our customers, rapid flow of information and comprehensive local service.

Moreover, in most countries one can find Heraeus' sales offices with skilled staff for local support.

In addition to product expertise we are also skilled in the field of precious metal management. In close collaboration with Heraeus' own metal trading company we offer our customers tailor-made concepts for procuring precious metals and their subsequent positioning.

Full cycle operations for the recovery of precious metals, and the administration of precious metal weight accounts, are an integral part of our daily business.

In this brochure our commercially available precious metal chemicals are described.

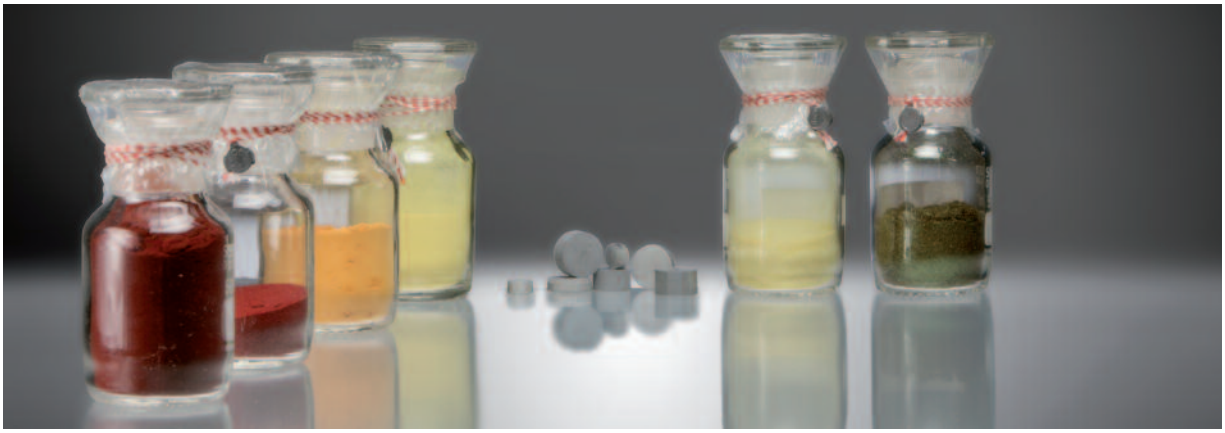
The latest equipment for top-quality compounds

We are continuously developing and expanding our product range in line with market demand. Heraeus welcomes direct contact for custom synthesis and new compounds enquiries.

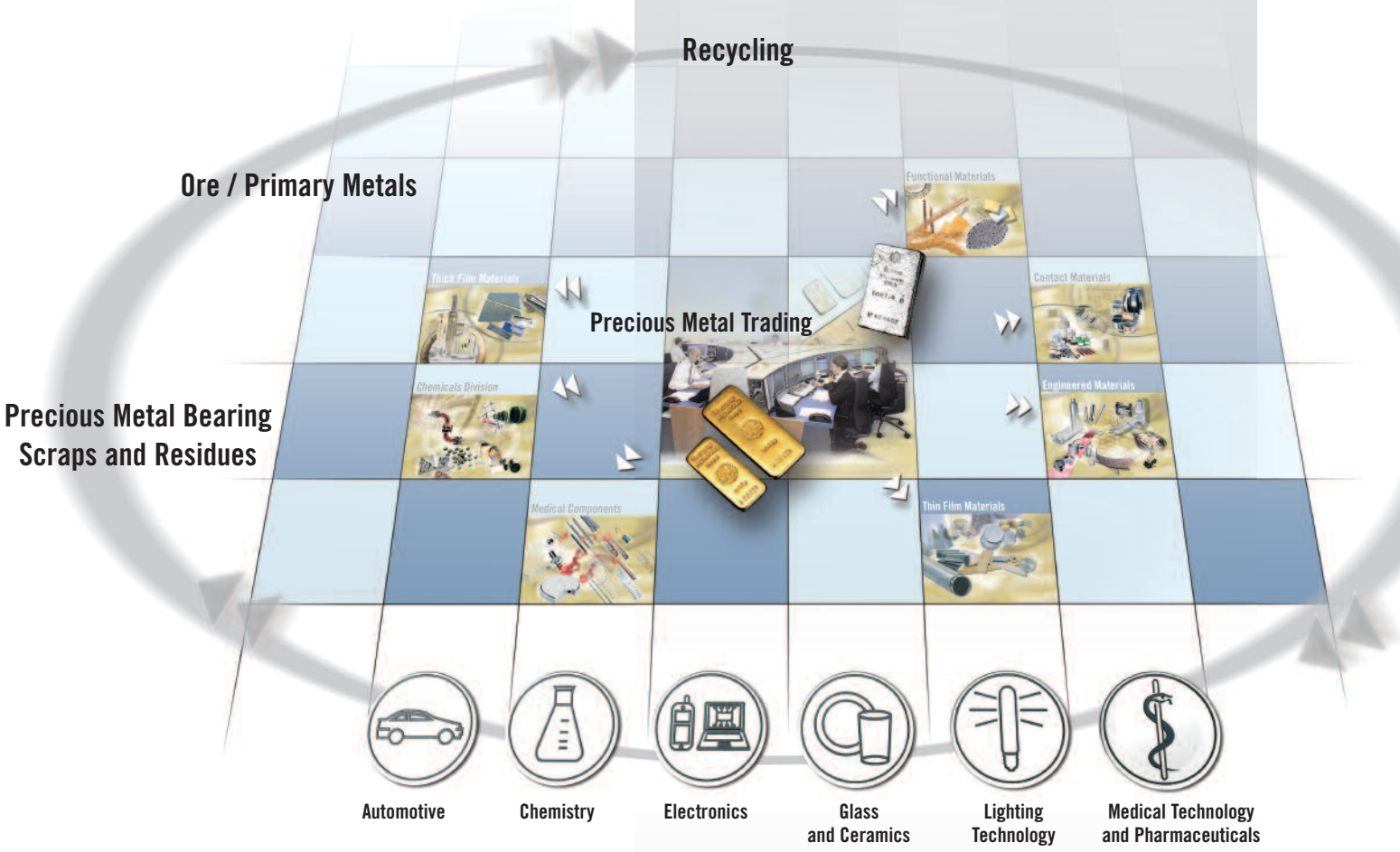
Heraeus' "Chemical Products" – your reliable partner for sophisticated precious metal chemistry.

You will find our latest news at our website:
www.heraeus-chemicalproducts.com

Enquiries for supported or heterogeneous precious metal catalysts should be directed to our colleagues of Heraeus' "Catalysts" on phone: +49 (61 81) 35 42 39 or at:
www.heraeus-catalysts.com

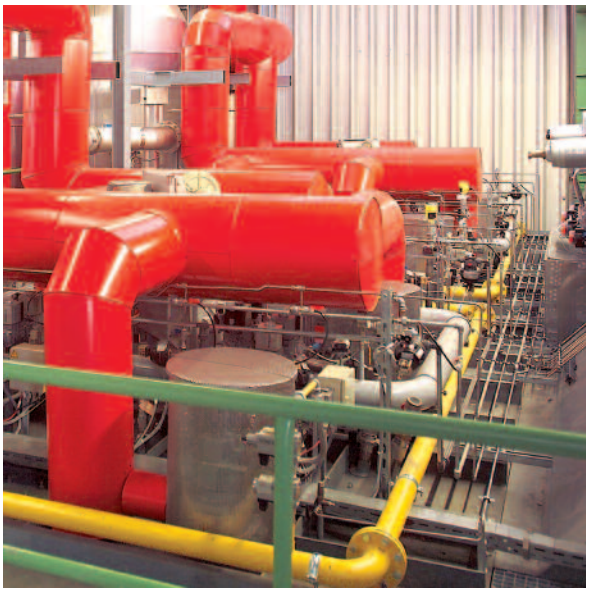


The Precious Metal Cycle



Key Markets

Precious Metal Refining –
Highest Quality through the Most Modern Equipment



HeraCYCLE®: A highly flexible and robust technology
for thermal treatment of refining materials

Spent homogeneous catalysts

Precious metal catalysis with recycling of spent catalysts!

Thermal reduction is a key step in the treatment of precious metal containing materials. This process ensures the drying of material and the increase of precious metal concentrations and is therefore an essential foundation for the homogenization and sampling of spent materials.

Typically spent heterogeneous catalysts such as carbon catalysts, resins and sludges as well as precious metal containing items from the electronics, glass or decorative coating industries are treated in this way.

Heraeus has recently invested into capacity expansion at its facilitites in Hanau/Germany, Wartburg/Tennessee, and Taicang/China and thus has significantly increased the range of treatable materials. In Hanau we have comissioned the HeraCYCLE® process for thermal processing.

This process is focused on the treatment of catalysts from the chemical, petrochemical or pharmaceutical industries – from homogeneous catalysis in particular.

The technology used in this robust unit is based on our substantial experience in the treatment of precious metals and is designed to facilitate treatment of materials with more and more complex and ever changing matrices. We can ensure a professional treatment of all intake materials regardless of their consistency.

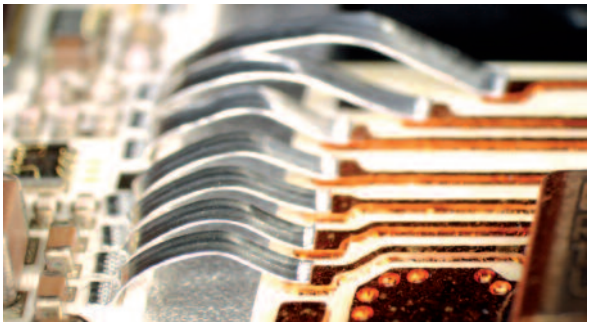
Our proprietary process meets all regulatory and environmental standards and has been permitted without problems.

All material is treated in a batch process ensuring that each customer's lot is treated separately and that the precious metals contained can be balanced correctly.

Heraeus is ready to convert your recovered metal into the precious metal compounds and homogeneous catalysts you need for your process.

Close your precious metal loop now... with Heraeus!

Innovative Technologies – Precious Metal Compounds for the 21st Century



Also in the 21st century precious metal compounds are indispensable. Besides classical applications like catalysis and electroplating, the reduction in use of raw materials and fossil energy is the clear focus in technological progress worldwide.

This includes innovative technologies for illumination, for miniaturization in the field of electronics, and for the industrial usage of renewable energies.

LEDs ("Light-Emitting Diodes") are seen in everyday life. For example LEDs are found in flashlights, automotive dashboards and cell phones.

Advantages of LEDs are a substantial saving of energy, no maintenance, adjusted coloring, flexible arrangements, and in particular they take up less space.

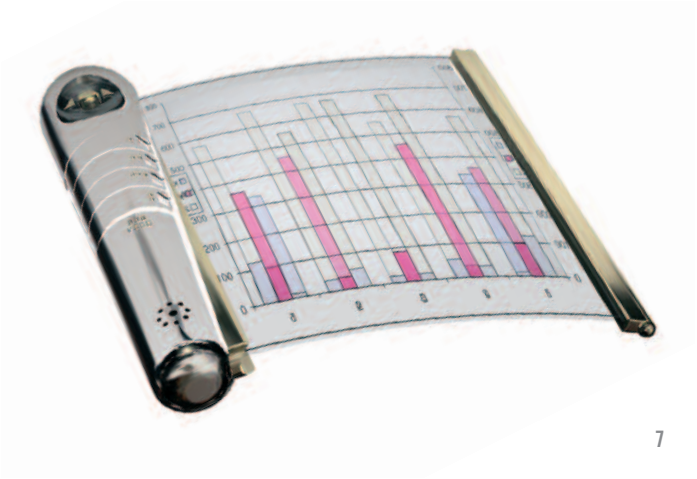
The increasing miniaturization of electronic components in line with requirements for highest purity levels need innovative solutions for ultra-thin metal layers.

"PLEDs" are based on organic polymers and are perfect for use for flexible films. For example, a new application is the so-called "E-Paper". PLEDs are normally manufactured with homogeneous catalysis using palladium ("C-C coupling reaction"). Heraeus offers you a wide range of homogeneous catalysts.

The latest developments for the manufacture of blue emitters for screens are based on organic or organometallic materials (**"OLEDs"**, "Organic-Light-Emitting Diodes"), e.g. highly sophisticated precious metal complexes of iridium.

Here, the established sputter technologies are often not precise enough. However, **"MOCVD"** ("Metal-Organic Chemical Vapor Deposition") offers decisive advantages: high-purity deposition of metals from the gas phase on a nm scale. In this field the term **"ALD"** ("Atomic Layer Deposition") is used, too. Also recently platinum group metals complexes, e.g. Ruthenium, with organic ligands have been applied to MOCVD.

Solar cells of the 3rd generation are based on deep-colored metal complexes which absorb light energy and so generate electric voltage by using physical-chemical processes. They are called **"DSCs"** ("Dye-Sensitized Cells"), or simply "Solar Dyes". Ruthenium in particular has proven to be very efficient for this application.



Gold –
Tradition in Jewelry for Milleniums

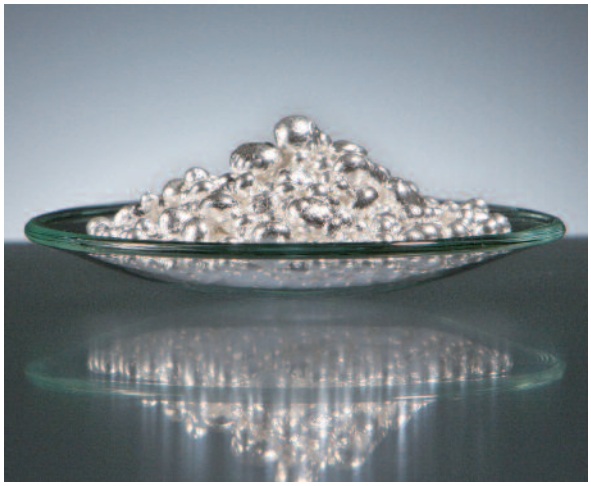
Gold Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Chloro(triphenylphosphane)gold(I)	$[AuCl(PPh_3)]$	103	39%	14243-64-2	colorless
Gold(III) hydroxide	$Au(OH)_3$	105	80%	1303-52-2	orange-brown
Hydrogen tetrachloroaurate(III) hydrate "Chloroauric Acid", "Gold Chloride Yellow"	$H[AuCl_4] \cdot nH_2O$	106	50%	16903-35-8	orange
Hydrogen tetrachloroaurate(III) *solution* "Chloroauric Acid"	$H[AuCl_4]$	107	up to 40%	16903-35-8	orange
Potassium dicyanoaurate(I) "Gold Salt", "Potassium Gold Cyanide"	$K[Au(CN)_2]$	108	68.2%	13967-50-5	colorless
Potassium tetrachloroaurate(III)	$K[AuCl_4]$	109	52%	13682-61-6	yellow
Potassium tetracyanoaurate(III)	$K[Au(CN)_4]$	110	58%	14263-59-3	colorless
Sodium tetrabromoaurate(III)	$Na[AuBr_4]$	112	33%	52495-41-7	black-purple

Silver – Element for Photography and the Manufacture of Mirrors

Silver Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Potassium dicyanoargentate(I) "Potassium Silver Cyanide"	$K[Ag(CN)_2]$	201	54%	506-61-6	colorless
Silver(I) acetate	Ag(OAc)	202	64%	563-63-3	colorless
Silver(I) carbonate	Ag_2CO_3	203	78%	534-16-7	yellow
Silver(I) chloride	AgCl	204	75%	7783-90-6	colorless
Silver(I) cyanide	AgCN	205	80%	506-64-9	colorless
Silver(I) nitrate	$AgNO_3$	206	63%	7761-88-8	colorless
Silver(I) oxide	Ag_2O	207	93%	20667-12-3	brown
Silver(II) oxide	AgO	208	87%	1301-96-8	black
Silver(I) sulfate	Ag_2SO_4	209	69%	10294-26-5	colorless



Platinum – Catalytic Refining of Petrochemical Raw Materials

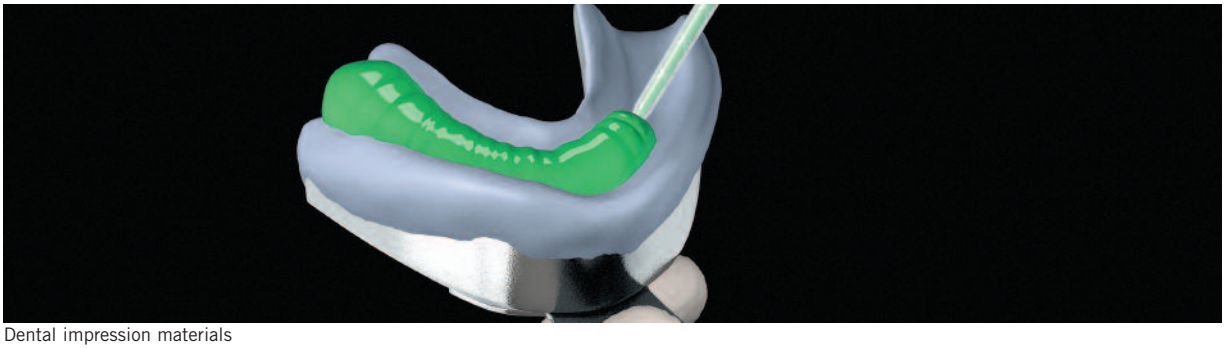
High-octane fuels for petrochemical refineries

Platinum Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Ammonium hexachloroplatinate(IV)	$(NH_4)_2[PtCl_6]$	301	44%	16919-58-7	yellow
Ammonium tetrachloroplatinate(IV)	$(NH_4)_2[PtCl_4]$	302	52%	13820-41-2	red
Bis(acetylacetonato)platinum(II)	$[Pt(acac)_2]$	303	50%	15170-57-7	yellow
cis-Diamminedichloroplatinum(II)	*cis*-$[PtCl_2(NH_3)_2]$	305	65%	15663-27-1	yellow
cis-Diamminedinitritoplatinum(II) *ammoniacal solution*	*cis*-$[Pt(NO_2)_2(NH_3)_2]$	306	up to 5 %	14286-02-3	yellow
cis-Diamminedinitritoplatinum(II) *nitric-acid solution*	*cis*-$[Pt(NO_2)_2(NH_3)_2]$	307	10%	14286-02-3	yellow
cis-Diamminedinitritoplatinum(II) *suspension*	*cis*-$[Pt(NO_2)_2(NH_3)_2]$	308	up to 10 %	14286-02-3	beige
cis-Dibromobis(triphenylphosphite)-platinum(II)	*cis*-$[PtBr_2\{P(OPh)_3\}_2]$	309	20%	41871-81-2	pale yellow
Dibromo(cycloocta-1,5-diene)platinum(II)	$[PtBr_2(cod)]$	310	42%	12145-48-1	pale yellow
Di-μ-chloro-bis[chloro(cyclohexene)-platinum(II)]	$[\{PtCl(C_6H_{10})\}_2(\mu\text{-}Cl)_2]$	311	55%	12176-53-3	beige
cis-Dichlorobis(triphenylphosphane)-platinum(II)	*cis*-$[PtCl_2(PPh_3)_2]$	312	24%	10199-34-5	colorless
Dichloro(cycloocta-1.5-diene)platinum(II)	$[PtCl_2(cod)]$	313	52%	12080-32-9	beige
Dihydrogen hexachloroplatinate(IV) hydrate "Chloroplatinic Acid", "CPA"	$H_2[PtCl_6] \cdot nH_2O$	314	40%	26023-84-7	orange
Dihydrogen hexachloroplatinate(IV) *solution*[1] "Chloroplatinic Acid", "CPA"	$H_2[PtCl_6]$	315	up to 32 %	16941-12-1	orange
Dihydrogen hexachloroplatinate(IV) *solution in isopropanol* "Speier's Catalyst"	$H_2[PtCl_6]$ / *i*-PrOH	316	up to 15%	26023-84-7	orange
Dihydrogen hexahydroxoplatinate(IV) "Hydroxoplatinic Acid"	$H_2[Pt(OH)_6]$	317	56%	51850-20-5	yellow
Dihydrogen dinitritodisulfitoplatinate(IV) *solution* "Pt DNS"	$H_2[Pt(NO_2)_2(SO_3)_2]$	318	up to 5%	68958-85-0	yellow
2-Hydroxyethylammonium hexahydroxoplatinate(IV) *solution* "Pt EA"	$(HOC_2H_4NH_3)_2[Pt(OH)_6]$	319	up to 12%		pale yellow
Platinum(II) chloride	$PtCl_2$	320	73%	10025-65-7	light brown
Platinum(IV) chloride	$PtCl_4$	321	58%	13454-96-1	reddish brown
Platinum(0) divinyltetramethylsiloxane complex[2] "Karstedt Concentrate"	"$[Pt_2(C_8H_{18}OSi_2)_3]$"	322	19%	68478-92-2	yellow

[1] Also available in organic solvents upon request
[2] Also available as tailor-made blends upon request

Platinum – Curing Catalyst for the Manufacture of Silicones



Dental impression materials

Platinum Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Platinum(II) nitrate	$Pt(NO_3)_2$	323	58%	18496-40-7	orange-brown
Platinum(II) nitrate *solution*	$Pt(NO_3)_2$	324	up to 30%	18496-40-7	orange-brown
Platinum(IV) oxide hydrate "Adam's Catalyst"	$PtO_2 \cdot nH_2O$	325	80%	52785-06-5	brown
Platinum sulfite *solution*	"$Pt(SO_3)_x$"	326	up to 10 %	61420-92-6	yellow
Potassium hexachloroplatinate(IV)	$K_2[PtCl_6]$	327	40%	16921-30-5	yellow
Potassium hexahydroxoplatinate(IV) *solution*	$K_2[Pt(OH)_6]$	328	up to 20%	12285-90-4	yellow
Potassium hexahydroxoplatinate(IV)	$K_2[Pt(OH)_6]$	329	52%	12285-90-4	yellow
Potassium tetrachloroplatinate(II)	$K_2[PtCl_4]$	330	47%	10025-99-7	red
Potassium tetranitritoplatinate(II) or: Potassium tetranitroplatinate(II)	$K_2[Pt(NO_2)_4]$	331	42%	13815-39-9	colorless
Sodium hexachloroplatinate(IV) hydrate	$Na_2[PtCl_6] \cdot nH_2O$	332	35%	19583-77-8	red
Sodium tetrachloroplatinate(II) *solution*	$Na_2[PtCl_4]$	334	up to 8 %	10026-00-3	red
Tetraammineplatinum(II) chloride hydrate "TPC Pt"	$[Pt(NH_3)_4]Cl_2 \cdot nH_2O$	336	55%	13933-32-9	yellowish
Tetraammineplatinum(II) chloride *solution* "TPC Pt"	$[Pt(NH_3)_4]Cl_2$	337	up to 6 %	16971-49-6	yellowish
Tetraammineplatinum(II) hydrogencarbonate "TPHC Pt"	$[Pt(NH_3)_4](HCO_3)_2$	338	51%	123439-82-7	colorless
Tetraammineplatinum(II) hydrogenphosphate *solution*	$[Pt(NH_3)_4]HPO_4$	339	up to 2 %	127733-98-6	colorless
Tetraammineplatinum(II) hydroxide *solution* "TPH Pt"	$[Pt(NH_3)_4](OH)_2$	340	up to 10 %	38201-97-7	colorless
Tetraammineplatinum(II) nitrate *solution* "TPN Pt"	$[Pt(NH_3)_4](NO_3)_2$	341	3%	20634-12-2	pale yellow
Tetraammineplatinum(II) nitrate *low pH solution* "TPN Pt"	$[Pt(NH_3)_4](NO_3)_2$	342	up to 4 %	20634-12-2	pale yellow
Tetrakis(triphenylphosphane)platinum(0)	$[Pt(PPh_3)_4]$	343	15%	14221-02-4	yellow

Palladium – Active in Hydrogenation Catalysts for the Chemical Industries

Petrochemistry requires supported palladium catalysts for selective hydrogenations.

Palladium Compounds

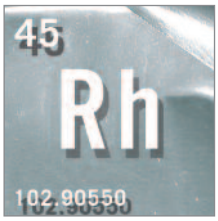
	Formula	Code	Metal Contained approx.	CAS	Color
Ammonium hexachloropalladate(IV)	$(NH_4)_2[PdCl_6]$	401	30%	19168-23-1	reddish brown
Ammonium tetrachloropalladate(II)	$(NH_4)_2[PdCl_4]$	402	37%	13820-40-1	green
Bis(acetonitrile)dichloropalladium(II)	$[PdCl_2(MeCN)_2]$	403	41%	14592-56-4	yellow
Bis(acetylacetonato)palladium(II) "Palladium Acetylacetonate"	$[Pd(acac)_2]$	404	35%	14024-61-4	yellow
trans-Bis(benzonitrile)-dichloropalladium(II)	$[PdCl_2(PhCN)_2]$	405	27%	14220-64-5	yellow
Bis(dibenzylideneacetone)palladium(0)	$Pd(dba)_2$	406	20%	32005-36-0	reddish brown
Bis(ethylenediamine)palladium(II) chloride	$[Pd(en)_2]Cl_2$	407	35%	13963-53-6	beige
Diamminedichloropalladium(II)	$[PdCl_2(NH_3)_2]$	408	50%	14323-43-4	yellow
Diamminedinitritopalladium(II) *ammoniacal solution* "Palladium P Salt Solution"	$[Pd(NO_2)_2(NH_3)_2]$	409	up to 18 %	14708-52-2	yellow
Dichloro[1,2-bis(diphenylphosphano)-ethane]palladium(II) or: Dichloro[ethane-1,2-diylbis(diphenylphosphane)]palladium(II)	$[PdCl_2(dppe)]$	410	18%	19978-61-1	off-white
Dichloro[1,3-bis(diphenylphosphano)-propane]palladium(II) or: Dichloro-[propane-1,3-diylbis(diphenylphosphane)]-palladium(II)	$[PdCl_2(dppp)]$	411	18%	59831-02-6	off-white
Dichlorobis(triphenylphosphane)-palladium(II)	$[PdCl_2(PPh_3)_2]$	412	15%	13965-03-2	yellow
Dichloro(cycloocta-1.5-diene)palladium(II)	$[PdCl_2(cod)]$	413	37%	12107-56-1	yellow
Dichloro[1,1'-ferrocenylbis-(diphenylphosphane)]palladium(II)	$[PdCl_2(dppf)]$	414	13%	72287-26-4	red
Dichloro[1.1'-ferrocenylbis-(diphenylphosphane)]palladium(II) dichloromethane	$[PdCl_2(dppf)] \cdot CH_2Cl_2$	415	13%	95464-05-4	red
Dihydrogen tetrachloropalladate(II) *solution* "Palladium Chloride Solution"	$H_2[PdCl_4]$	416	up to 20%	7647-10-1	brown
Palladium(II) acetate	$Pd(OAc)_2$	417	47%	3375-31-3	yellowish brown
Palladium(II) bromide	$PdBr_2$	418	40%	13444-94-5	violet
Palladium(II) chloride	$PdCl_2$	419	60%	7647-10-1	brown
Palladium(II) nitrate hydrate	$Pd(NO_3)_2 \cdot nH_2O$	420	41%	10102-05-3	yellowish brown
Palladium(II) nitrate *solution*	$Pd(NO_3)_2$	421	up to 17%	10102-05-3	yellowish brown
Palladium(II) sulfate *solution*	$PdSO_4$	424	up to 12 %	13566-03-5	brown

Palladium – Homogeneous Catalysts for Liquid Crystal Technologies

Palladium Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Palladium(II) trifluoroacetate	$Pd(CF_3CO_2)_2$	425	32%	42196-31-6	light brown
Potassium hexachloropalladate(IV)	$K_2[PdCl_6]$	426	27%	16919-73-6	red
Potassium tetrachloropalladate(II)	$K_2[PdCl_4]$	427	32%	10025-98-6	brown
Sodium tetrachloropalladate(II)	$Na_2[PdCl_4]$	428	36%	13820-53-6	brown
Sodium tetrachloropalladate(II) *solution*	$Na_2[PdCl_4]$	429	up to 15 %	13820-53-6	brown
Tetraamminepalladium(II) chloride "TPC Pd"	$[Pd(NH_3)_4]Cl_2$	431	42%	13815-17-3	yellow
Tetraamminepalladium(II) chloride *solution* "TPC Pd"	$[Pd(NH_3)_4]Cl_2$	432	up to 10%	13815-17-3	yellow
Tetraamminepalladium(II) hydrogencarbonate "TPHC Pd"	$[Pd(NH_3)_4](HCO_3)_2$	433	35%	134620-00-1	cream
Tetraamminepalladium(II) hydroxide *solution* "TPH Pd"	$[Pd(NH_3)_4](OH)_2$	434	up to 5 %	68413-68-3	yellowish
Tetraamminepalladium(II) nitrate "TPN Pd"	$[Pd(NH_3)_4](NO_3)_2$	435	35%	13601-08-6	pale yellow
Tetraamminepalladium(II) nitrate *solution* "TPN Pd"	$[Pd(NH_3)_4](NO_3)_2$	436	up to 6 %	13601-08-6	light brown
Tetraamminepalladium(II) sulfate *solution*	$[Pd(NH_3)_4]SO_4$	438	up to 4 %	13601-06-4	yellow
Tetrakis(triphenylphosphane)palladium(0)	$[Pd(PPh_3)_4]$	439	9%	14221-01-3	yellowish green
Tris(dibenzylideneacetone)dipalladium(0)	$Pd_2(dba)_3$	440	20%	52409-22-0	reddish brown
Tris(dibenzylideneacetone)dipalladium(0) dibenzylideneacetone	$Pd_2(dba)_3 \cdot dba$	441	20%	51364-51-3	reddish brown

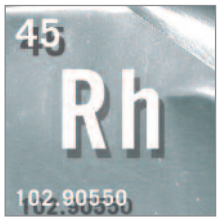
Rhodium – Homogeneous Catalysis for the Production of Acetic Acid and Oxo Aldehydes



Rhodium Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
(Acetylacetonato)carbonyl-(triphenylphosphane)rhodium(I) "ROPAC"	$[Rh(acac)(CO)(PPh_3)]$	501	21%	25470-96-6	yellow
Acetylacetonato(cycloocta-1,5-diene)-rhodium(I)	$[Rh(acac)(cod)]$	502	33%	12245-39-5	yellow
(Acetylacetonato)dicarbonylrhodium(I) "CARAC"	$[Rh(acac)(CO)_2]$	503	40%	14874-82-9	red - green
Ammonium hexachlororhodate(III)	$(NH_4)_3[RhCl_6]$	504	27%	15336-18-2	red
Bis(cycloocta-1,5-diene)rhodium(I) tetrafluoroborate	$[Rh(cod)_2]BF_4$	508	25%	35138-22-8	reddish brown
Carbonylchlorobis(triphenylphosphane)-rhodium(I)	$[RhCl(CO)(PPh_3)_2]$	510	appr. 15 %	13938-94-8	yellow
Carbonylhydridotris(triphenylphosphane)-rhodium(I) "RODRIDO"	$[RhH(CO)(PPh_3)_3]$	511	11%	17185-29-4	yellow
Chlorotris(triphenylphosphane)rhodium(I) "Wilkinson's Catalyst"	$[RhCl(PPh_3)_3]$	512	11%	14694-95-2	red
Di-µ-acetato-bis[acetatorhodium(II)] "Green Rhodium Acetate"	$[\{Rh(OAc)\}_2(\mu\text{-}OAc)_2]$	513	46%	15956-28-2	green
Di-µ-chloro-bis[chloro-(pentamethylcyclopentadienyl)rhodium(III)]	$[\{RhClCp^*\}_2(\mu\text{-}Cl)_2]$	515	33%	12354-85-7	reddish brown
Di-µ-chloro-bis[(cycloocta-1.5-diene)-rhodium(I)]	$[\{Rh(cod)\}_2(\mu\text{-}Cl)_2]$	516	42%	12092-47-6	yellow

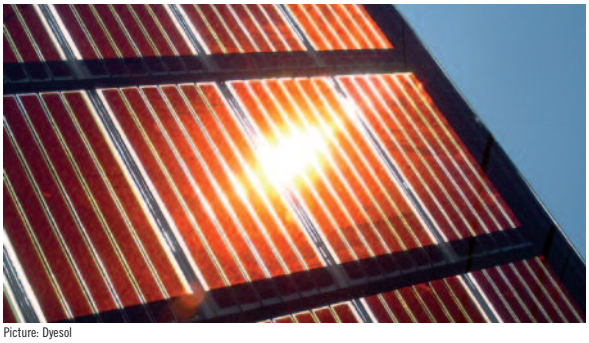
Rhodium –
Emission Control and Brilliant Surfaces



Rhodium Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Hexaamminerhodium(III) chloride *solution*	$[Rh(NH_3)_6]Cl_3$	520	up to 2 %	13820-96-7	colorless
Hexaamminerhodium(III) hydroxide *solution*	$[Rh(NH_3)_6](OH)_3$	521	up to 8%		pale yellow
Rhodium acetate	"$Rh(OAc)_x$"	523	39%	42204-14-8 26105-49-7	brown
Rhodium acetate *acetic solution*	"$Rh(OAc)_x$"	524	up to 8%	42204-14-8 26105-49-7	brown
Rhodium(III) chloride	$RhCl_3$	527	49%	10049-07-7	red
Rhodium(III) chloride hydrate	$RhCl_3 \cdot nH_2O$	528	38%	20765-98-4	red
Rhodium(III) chloride *solution*	$RhCl_3$	529	up to 20%	13569-65-8	red
Rhodium 2-ethylhexanoate *solution in 2-ethyl hexanol* "Rh 2-EH"	"$Rh_2(C_8H_{15}O_2)_4$"	530	up to 2 %	20845-92-5	reddish brown
Rhodium(III) iodide	RhI_3	531	21%	15492-38-3	black
Rhodium(III) nitrate hydrate	$Rh(NO_3)_3 \cdot nH_2O$	532	40%	13465-43-5	brown
Rhodium(III) nitrate *solution*	$Rh(NO_3)_3$	533	up to 13%	10139-58-9	brown
Rhodium(III) phosphate *solution*	$RhPO_4$	535	up to 3 %	67859-71-6	yellow - red
Rhodium(III) sulfate *solution*	$Rh_2(SO_4)_3$	536	up to 12%	10489-46-0	brown
Rhodium sulfite *solution*	"$Rh(SO_3)_x$"	537	up to 6 %		brownish yellow

Ruthenium – Essential to High-Capacity Hard Disks



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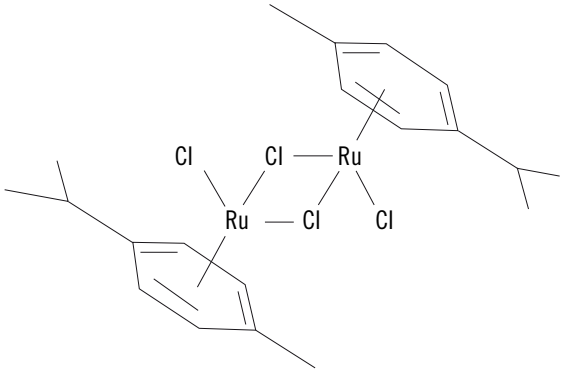
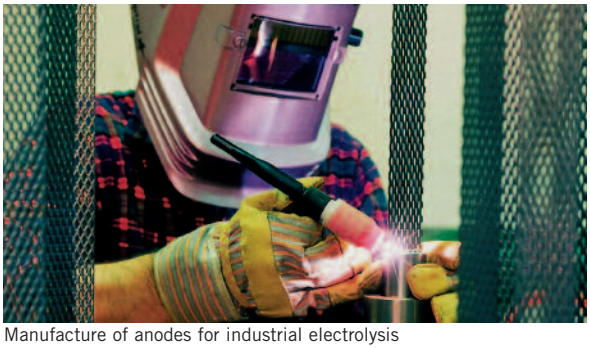


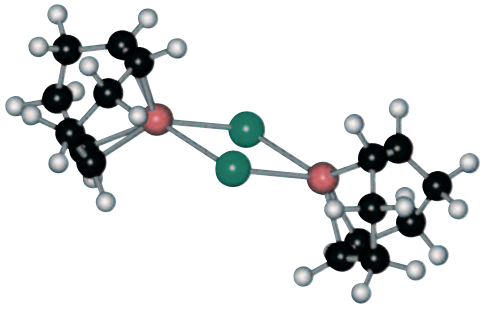
Ruthenium Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Ammonium hexachlororuthenate(IV)	$(NH_4)_2[RuCl_6]$	701	31%	18746-63-9	brown
Ammonium µ-nitrido-bis-[aquatetrachlororuthenate(IV)]	$(NH_3)_4[\{RuCl_4(H_2O)\}_2(\mu\text{-}N)]$	702	34%	27316-90-1	red
Carbonyldihydridotris(triphenylphosphane)-ruthenium(II)	$[Ru(H)_2(CO)(PPh_3)_3]$	703	11%	25360-32-1	cream
Di-µ-chloro-bis[chloro(*p*-cymene)-ruthenium(II)]	$[\{RuCl(C_{10}H_{14})\}_2(\mu\text{-}Cl)_2]$	704	33%	52462-29-0	reddish brown
Dichloro(cycloocta-1.5-diene)ruthenium(II)	$[RuCl_2(cod)]_n$	705	35%	50982-12-2	brown
Dichlorotris(triphenylphosphane)-ruthenium(II)	$[RuCl_2(PPh_3)_3]$	706	10%	15529-49-4	reddish brown
Ruthenium acetate	"$Ru(OAc)_x$"	708	47%	55466-76-7	black
Ruthenium(III) chloride hydrate	$RuCl_3 \cdot nH_2O$	710	40%	14898-67-0	brownish black
Ruthenium(III) chloride *solution*	$RuCl_3$	711	up to 20%	10049-08-8	brown
Trinitratonitrosylruthenium(II)	$[Ru(NO_3)_3(NO)]$	715	30%	34513-98-9	reddish brown
Trinitratonitrosylruthenium(II) *solution*	$[Ru(NO_3)_3(NO)]$	716	up to 15%	34513-98-9	claret
Trinitratonitrosylruthenium(II) *technical solution*	$[Ru(NO_3)_3(NO)]$	717	up to 15%	34513-98-9	brown
Tris(acetylacetonato)ruthenium(III) "Ruthenium Acetylacetonate"	$[Ru(acac)_3]$	718	25%	14284-93-6	red
Ruthenium acetate solution	"$Ru(OAc)_x$"	719	up to 8%	55466-76-7	dark green

Iridium – Anodes for the Production of Chlorine and Sodium Hydroxide Solution



Manufacture of anodes for industrial electrolysis



Molecular structure of di-μ-chloro-bis[(cycloocta-1.5-diene)iridium(I)]

Iridium Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Ammonium hexachloroiridate(IV)	$(NH_4)_2[IrCl_6]$	602	43%	16940-92-4	black
Bis(cycloocta-1,5-diene)iridium(I) tetrafluoroborate	$[Ir(cod)_2]BF_4$	603	38%	35138-23-9	dark purple
Di-μ-chloro-bis[chloro-(pentamethylcyclopentadienyl)iridium(III)]	$[\{IrClCp^*)_2(\mu\text{-}Cl)_2]$	604	48%	12354-84-6	orange-red
Di-μ-chloro-bis[(cycloocta-1.5-diene)-iridium(I)]	$[\{Ir(cod)\}_2(\mu\text{-}Cl)_2]$	605	57%	12112-67-3	orange-red
Dihydrogen hexachloroiridate(IV) hydrate "Chloroiridic Acid"; "CIA"	$H_2[IrCl_6] \cdot nH_2O$	606	43%	16941-92-7	black
Dihydrogen hexachloroiridate(IV) *solution* "Chloroiridic Acid"; "CIA"	$H_2[IrCl_6]$	607	up to 25%	16941-92-7	brown
Iridium acetate	"$Ir(OAc)_x$"	608	48%	52705-52-9	green
Iridium(III) chloride hydrate	$IrCl_3 \cdot nH_2O$	610	54%	14996-61-3	green
Iridium(III) chloride hydrate, Type G	$IrCl_3 \cdot nH_2O$	611	54%	14996-61-3	green
Iridium(III) chloride *solution*	$IrCl_3$	612	up to 10 %	10025-83-9	dark brown
Iridium(IV) chloride hydrate	$IrCl_4 \cdot nH_2O$	613	53%	10025-97-5	black
Iridium(IV) oxide	IrO_2	614	85%	12030-49-8	deep blue
Potassium hexachloroiridate(III)	$K_3[IrCl_6]$	617	37%	14024-41-0	dark green
Potassium hexachloroiridate(IV)	$K_2[IrCl_6]$	618	39%	16920-56-2	black
Ir black	Ir	619	98%	7439-88-5	black
Tris(acetylacetonato)iridium(III) "Iridium Acetylacetonate"	$[Ir(acac)_3]$	621	37%	15635-87-7	yellowish green
Iridium acetate *solution*	"$Ir(OAc)_x$"	622	up to 8 %	52705-52-9	teal

Osmium –
Fixing Agent for Modern Microscopy

Osmium Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Ammonium hexachloroosmate(IV)	$(NH_4)_2[OsCl_6]$	901	43%	12125-08-5	red-black
Osmium(III) chloride hydrate	$OsCl_3 \cdot nH_2O$	902	55%	14996-60-2	black
Osmium(VIII) oxide	OsO_4	903	75%	20816-12-0	yellow
Osmium(VIII) oxide *solution*	OsO_4	904	up to 3 %	20816-12-0	yellow
Potassium hexachloroosmate(IV)	$K_2[OsCl_6]$	905	39%	16871-60-6	red
Potassium tetrahydroxodioxoosmate(VI) "Potassium Osmate"	$K_2[Os(O)_2(OH)_4]$	906	52%	10022-66-9	violet
Sodium hexachloroosmate(IV) hydrate	$Na_2[OsCl_6] \cdot nH_2O$	907	39%	1307-81-9	red-black

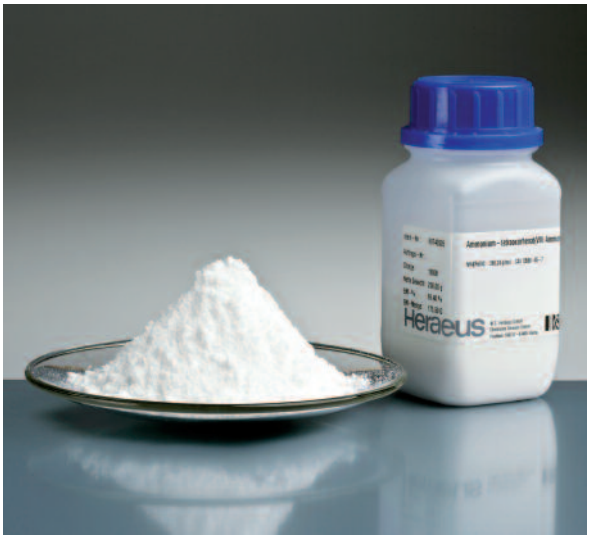
OsO_4 solution of highest purity

OsO_4 crystals in ampules

Rhenium – High-Speed Turbines for Today's Air Traffic Worldwide

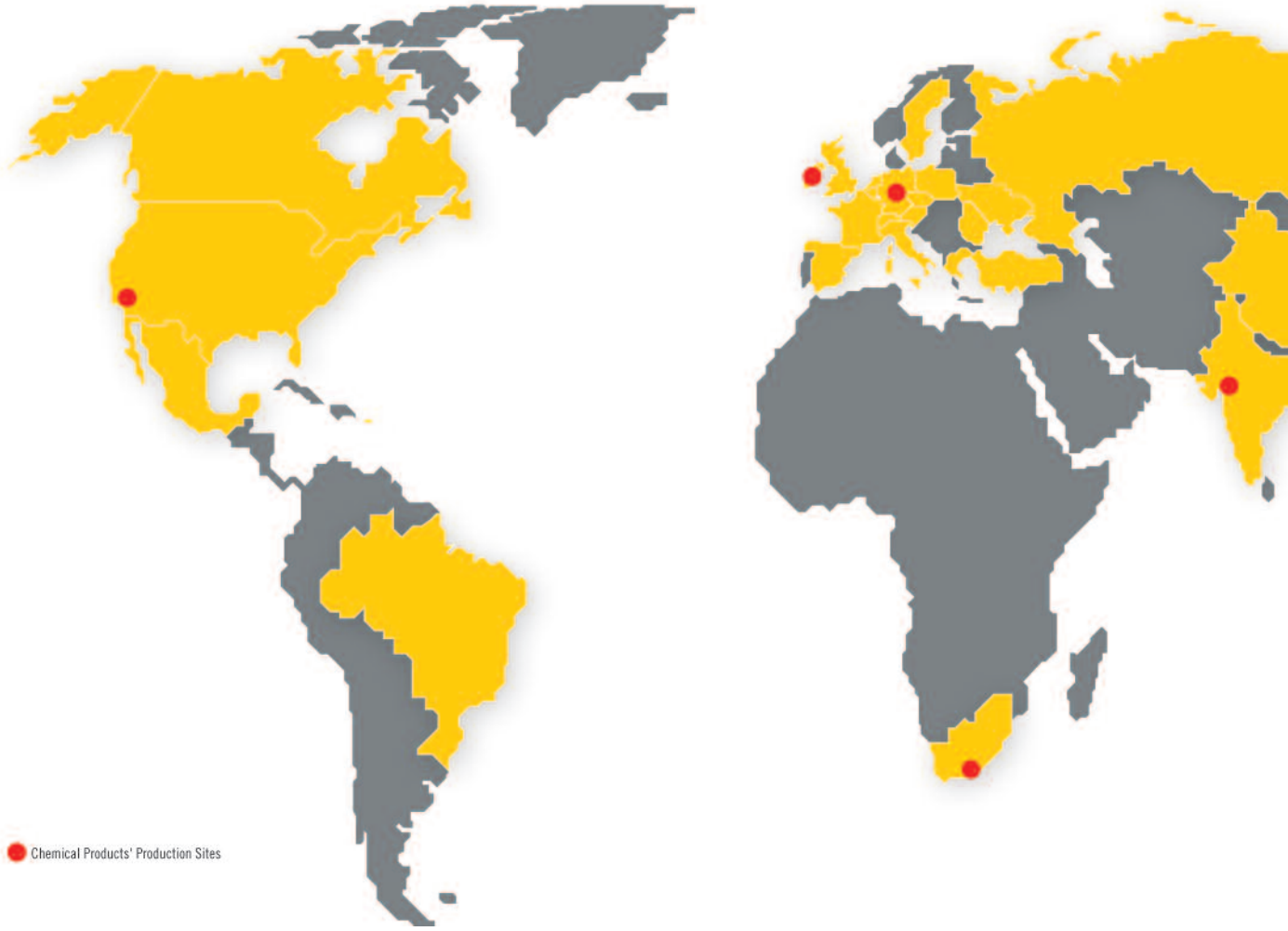
Rhenium Compounds

	Formula	Code	Metal Contained approx.	CAS	Color
Ammonium tetraoxorhenate(VII) "Ammonium Perrhenate"	$NH_4[ReO_4]$	801	69%	13598-65-7	colorless
Hydroxotrioxorhenium(VII) *solution* "Perrhenic Acid"	$[HReO_4]$	802	up to 60 %	13768-11-1	colorless
Potassium tetraoxorhenate(VII)	$K[ReO_4]$	803	64%	10466-65-6	colorless
Rhenium *pellets*	Re	804	min. 99.9 %	7440-15-5	grey
Rhenium *powder*	Re	805	min. 99.9 %	7440-15-5	grey



Rhenium pellets

Heraeus' Chemical Products all over the World



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All solutions in this brochure are aqueous as far as not specified otherwise. Formulae in quotation marks (“ ”) represent the idealized composition of empirical compounds.

Of course – besides the precious metal chemicals, homogeneous catalysts and their solutions in this brochure – Heraeus supplies you with the respective precious metals in highest purity and certified qualities.

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