Rhodium

From Wikipedia, the free encyclopedia

Rhodium is a chemical element with symbol **Rh** and atomic number 45. It is a rare, silvery-white, hard, and chemically inert transition metal. It is a member of the platinum group. It has only one naturally occurring isotope, ¹⁰³Rh. Naturally occurring rhodium is usually found as the free metal, alloyed with similar metals, and rarely as a chemical compound in minerals such as bowieite and rhodplumsite. It is one of the rarest and most valuable precious metals.

Rhodium is a noble metal, resistant to corrosion, found in platinum or nickel ores together with the other members of the platinum group metals. It was discovered in 1803 by William Hyde Wollaston in one such ore, and named for the rose color of one of its chlorine compounds, produced after it reacted with the powerful acid mixture aqua regia.

The element's major use (approximately 80% of world rhodium production) is as one of the catalysts in the three-way catalytic converters in automobiles. Because rhodium metal is inert against corrosion and most aggressive chemicals, and because of its rarity, rhodium is usually alloyed with platinum or palladium and applied in high-temperature and corrosion-resistive coatings. White gold is often plated with a thin rhodium layer to improve its appearance while sterling silver is often rhodium-plated for tarnish resistance.

Rhodium detectors are used in nuclear reactors to measure the neutron flux level.

Characteristics

Rhodium is a hard, silvery, durable metal that has a high reflectance. Rhodium metal does not normally form an oxide, even when heated.^[17] Oxygen is absorbed from the atmosphere only at the melting point of rhodium, but is released on solidification.^[18] Rhodium has both a higher melting point and lower density than platinum. It is not attacked by most acids: it is completely insoluble in nitric acid and dissolves slightly in aqua regia.

Rhodium, 45Rh



General properties

Name, symbol rhodium, Rh

Appearance silvery white metallic

Rhodium in the periodic table

Atomic number (Z) 45

Group, block group 9, d-block

Period period 5

Element category

| transition metal

Standard atomic weight (\pm) (A_r)

102.90550(2)[1]

Electron configuration

[Kr] 4d⁸ 5s¹

per shell 2, 8, 18, 16, 1

Physical properties

Phase solid

Melting point 2237 K (1964 °C,

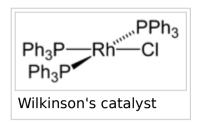
3567 °F)

Boiling point 3968 K (3695 °C,

6683 °F)

Density near r.t. 12.41 g/cm³

Chemical properties



Rhodium belongs to group 9 of the periodic table, but the configuration of electrons in the outermost shells is atypical for the group. This anomaly is also observed in the neighboring elements, niobium (41), ruthenium (44), and palladium (46).

The common oxidation state of rhodium is +3, but oxidation states from +0 to +6 are also observed.^[19]

Unlike ruthenium and osmium, rhodium forms no volatile oxygen compounds. The known stable oxides include Rh_2O_3 , RhO_2 , RhO_2 , xH_2O , Na_2RhO_3 , Sr_3LiRhO_6 and Sr_3NaRhO_6 . Halogen compounds are known in nearly the full range of possible oxidation states. Rhodium(III) chloride, rhodium(IV) fluoride, rhodium(V) fluoride and rhodium(VI) fluoride are examples. The lower oxidation states are stable only in the presence of ligands. [21]

The best-known rhodium-halogen compound is the Wilkinson's catalyst chlorotris(triphenylphosphine)rhodium(I). This catalyst is used in the hydroformylation or hydrogenation of alkenes.^[22]

Isotopes

Naturally occurring rhodium is composed of only one isotope, 103 Rh. The most stable radioisotopes are 101 Rh with a half-life of 3.3 years, 102 Rh with a half-life of 207 days, 102m Rh with a half-life of 2.9 years, and 99 Rh with a half-life of 16.1 days. Twenty other radioisotopes have been characterized with atomic weights ranging from 92.926 u (93 Rh) to 116.925 u (117 Rh). Most of these have half-lives shorter than an hour, except 100 Rh (20.8 hours) and 105 Rh (35.36 hours). It has numerous meta states, the most stable being 102m Rh (0.141 MeV) with a half-life of about 2.9 years and 101m Rh (0.157 MeV) with a half-life of 4.34 days (see isotopes of rhodium). $^{[23]}$

when liquid, at m.p. 10.7 g/cm³

Heat of fusion 26.59 kJ/mol

Heat of 493 kJ/mol vaporization

Molar heat

24.98 J/(mol·K)

capacity

Vapor pressure

P (Pa)	1	10	100	1 k	10 k	100 k
at T (K)	2288	2496	2749	3063	3405	3997

Atomic properties

Oxidation states 6, 5, 4, **3**, 2, 1, [2] -1, -3

(an amphoteric oxide)

Electronegativity Pauling scale: 2.28

Ionization 1st: 719.7 kJ/mol energies 2nd: 1740 kJ/mol 3rd: 2997 kJ/mol

empirical: 134 pm

Atomic radius empirical: 1

Covalent radius 142±7 pm

Miscellanea

Crystal structure face-centered cubic

(fcc)

Speed of sound 4700 m/s (at 20 °C)

thin rod

Thermal 8.2 μ m/(m·K) (at 25 °C)

expansion

Thermal 150 W/(m·K)

conductivity

Electrical 43.3 n Ω ·m (at 0 °C) resistivity

Magnetic ordering paramagnetic^[3]

In isotopes weighing less than 103 (the stable isotope), the primary decay mode is electron capture and the primary decay product is ruthenium In isotopes greater than 103, the primary decay mode is beta emission and the primary product is palladium.^[24]

Source

Wikipedia: Rhodium (https://en.wikipedia.org/wiki/Rhodium)

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Young's modulus 380 GPa
Shear modulus 150 GPa
Bulk modulus 275 GPa
Poisson ratio 0.26

Mohs hardness 6.0

Vickers hardness 1100-8000 MPa
Brinell hardness 980-1350 MPa

CAS Number 7440-16-6

History

Discovery and William Hyde Wollaston

first isolation (1804)

Most stable isotopes of rhodium

iso	60	NA	half- life	DM	DE (MeV)	DP
				ε	-	⁹⁹ Ru
⁹⁹ Rh	⁹ Rh	syn	16.1 d	Υ	0.089, 0.353, 0.528	-
		svn	4.34 d	ε	-	¹⁰¹ Ru
^{1m} Rh	m _{Rh}			IT	0.157	¹⁰¹ Rh
		- ,		Υ	0.306, 0.545	-
			Tife E C C C C C C C C C	¹⁰¹ Ru		
.01Rh	¹Rh	syn		γ Υ	0.198,	-
				ε	-	¹⁰² Ru
^{2m} Rh	^m Rh	syn	3.7 y	Y	0.631, 0.697,	-
		$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	-	¹⁰² Ru		
0251	251		207.6	Ι'		¹⁰² Ru
·°-Kn	-Kn		2070	β-	1.151	¹⁰² Pd
				γ		-
.03 Rh 1	³ Rh ¹	100%	is sta	ble v	with 58 neut	rons
.05Rh	⁵ Rh	syn 35.36	35.36 h		0.260,	¹⁰⁵ Pd
					0.306, 0.318	-