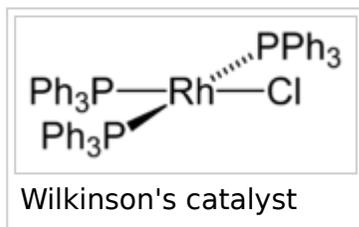




## Chemical properties



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.<sup>[19]</sup>

Unlike ruthenium and osmium, rhodium forms no volatile oxygen compounds. The known stable oxides include  $\text{Rh}_2\text{O}_3$ ,  $\text{RhO}_2$ ,  $\text{RhO}_2 \cdot x\text{H}_2\text{O}$ ,  $\text{Na}_2\text{RhO}_3$ ,  $\text{Sr}_3\text{LiRhO}_6$  and  $\text{Sr}_3\text{NaRhO}_6$ .<sup>[20]</sup> 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.<sup>[21]</sup>

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.<sup>[22]</sup>

## Isotopes

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

when liquid, at m.p. 10.7 g/cm<sup>3</sup>

**Heat of fusion** 26.59 kJ/mol

**Heat of vaporization** 493 kJ/mol

**Molar heat capacity** 24.98 J/(mol·K)

### 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,<sup>[2]</sup> −1, −3 (an amphoteric oxide)

**Electronegativity** Pauling scale: 2.28

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

**Atomic radius** empirical: 134 pm

**Covalent radius** 142±7 pm

### Miscellanea

**Crystal structure** face-centered cubic (fcc)



**Speed of sound** 4700 m/s (at 20 °C)  
thin rod

**Thermal expansion** 8.2 μm/(m·K) (at 25 °C)

**Thermal conductivity** 150 W/(m·K)

**Electrical resistivity** 43.3 nΩ·m (at 0 °C)

**Magnetic ordering** paramagnetic<sup>[3]</sup>

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.<sup>[24]</sup>

## Source

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

Retrieved from "https://en.wikipedia.org/w/index.php?title=Rhodium&oldid=753644905"

<b>Young's modulus</b>	380 GPa
<b>Shear modulus</b>	150 GPa
<b>Bulk modulus</b>	275 GPa
<b>Poisson ratio</b>	0.26
<b>Mohs hardness</b>	6.0
<b>Vickers hardness</b>	1100–8000 MPa
<b>Brinell hardness</b>	980–1350 MPa
<b>CAS Number</b>	7440-16-6

### History

<b>Discovery and first isolation</b>	William Hyde Wollaston (1804)
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### Most stable isotopes of rhodium

iso	NA	half-life	DM	DE (MeV)	DP
<b>99Rh</b>	syn	16.1 d	ε	-	<sup>99</sup> Ru
			γ	0.089, 0.353, 0.528	-
<b>101mRh</b>	syn	4.34 d	ε	-	<sup>101</sup> Ru
			IT	0.157	<sup>101</sup> Rh
			γ	0.306, 0.545	-
<b>101Rh</b>	syn	3.3 y	ε	-	<sup>101</sup> Ru
			γ	0.127, 0.198, 0.325	-
<b>102mRh</b>	syn	3.7 y	ε	-	<sup>102</sup> Ru
			γ	0.475, 0.631, 0.697, 1.046	-
<b>102Rh</b>	syn	207 d	ε	-	<sup>102</sup> Ru
			β <sup>+</sup>	0.826, 1.301	<sup>102</sup> Ru
			β <sup>-</sup>	1.151	<sup>102</sup> Pd
			γ	0.475, 0.628	-
<b>103Rh</b>	100%	is stable with 58 neutrons			
<b>105Rh</b>	syn	35.36 h	β <sup>-</sup>	0.247, 0.260, 0.566	<sup>105</sup> Pd
			γ	0.306, 0.318	-

