Mr. Everett's Web Page

Academic Decathlon | Adult School | Baseball | Chemistry Topics
Chemical Compounds | Interests | Numbers | Periodic Table
Physics | Reference | Sports | Students

PALLADIUM

Quick links:

Introduction | Classification | Description | Physical Properties
Electron Structure | Bonding Character | Thermodynamic Data | Video
Isotopes | Reactions | Composition | Compounds
Safety | Languages | For More Information | Sources

Back to the Periodic Table

Introduction

top

Atomic Number: 46

Average Atomic Mass: 106.42

Group: 10 or VIII B

Period: 5

CAS Number: 7440-05-3

46 106.42

Pd

Palladium

Classification

top

(•) Metal	( ) Nonmetal	( ) Metalloid		
( ) Alkali Metal	( ) Alkali Earth Metal	(•) Transition Metal	( ) Chalcogen	( ) Halogen
( ) Noble Gas	( ) Lanthanoid	( ) Actinoid		
( ) Transuranium	( ) No Stable Isotopes			
(•) Solid	( ) Liquid	( ) Gas	( ) Assumed Solid	

Description

top

Discovered in 1803 by Wollaston. Palladium is found along with platinum and other metals of the platinum group in placer deposits of Russia, South and North America, Ethiopia, and Australia. Natural palladium contains six stable isotopes. Twenty five other isotopes are recognized, all of which are radioactive. It is also found associated with the nickel-copper deposits of South Africa and Ontario. Its separation from the platinum metals depends upon the type of ore in which it is found. It is a steel-white metal, does not tarnish in air, and is the least dense and lowest melting of the platinum group of metals. When annealed, it is soft and ductile; cold working greatly increases its strength and hardness. Palladium is attacked by nitric and sulfuric acid. At room temperatures the metal has the unusual property of absorbing up to 900 times its own volume of hydrogen, possibly forming Pd2H. It is not yet clear if this a true compound. Hydrogen readily diffuses through heated palladium and this provides a means of purifying the gas. Finely divided palladium is a good catalyst and is used for hydrogenation and dehydrogenation reactions. It is alloyed and used in jewelry trades. White gold is an alloy of gold decolorized by the addition of palladium. Like gold, palladium can be beaten into leaf as thin as 1/250,000 in. The metal is used in dentistry, watchmaking, and in making surgical instruments and electrical contacts. The metal sells for about $140/troy oz. ($4.50/g). [1]

Physical Properties

top

Normal Melting Point:	1554.9 • = 1828.05 K = 2830.82 • [2]	**Normal Boiling Point:**	2963 • = 3236.15 K = 5365.4 • [2]
Sublimation Point:		**Triple Point:**	
Critical Point:			

Density:	12 g/cm^3	**Crystal Structure:**	cubic: face centered
Atomic Radius:	1.79 • = 179 pm	**Covalent Radius:**	1.28 • = 128 pm
Ionic Radius:	1 • = 100 pm	**Atomic Volume:**	8.9 cm^3/mol

Electron Structure

top

Predicted Electron Configuration: [Kr] 5s2 4d8

Actual Electron Configuration: [Kr] 4d10

Block: d

Highest Occupied Energy Level: 5

Valence Electrons: 1

Quantum Numbers for Last Electron: n = 4 • = 2 $m_•$ = 2 m_s = -?/font>

Lewis Dot Diagram

x

Pd

Please note that information in this section can be derived entirely from the periodic table. Although most people do not discuss valence electrons of the d-block and f-block elements, on this page the number of electrons in the highest energy level of the actual electron configuration was used to determine valence electrons.

Bonding Character

top

Electronegativity (Pauling): 2.2

Electron Affinity: 0.56 eV = 54.03 kJ/mol = 12.91 kcal/mol

Work Function: 5.00 eV [3] = 8.01E-19 J

Common Oxidation States: +2,4

Ionization Potential [4]	eV	kJ/mol	Ionization Potential [4]	eV	kJ/mol
1	8.3369	804.4	3	32.93	3177.3
2	19.43	1874.7			

Note: Only the electronvolt values are given in the CRC Handbook, a conversion factor was used to find the kJ/mol value.

Thermodynamic Data

top

Specific Heat: 0.24 J/g• = 0.057 cal/g•

Heat of Fusion: 17.6 kJ/mol = 165.4 J/g

Heat of Vaporization: 357 kJ/mol = 3354.6 J/g

Thermal Conductivity: 71.8 (W/m)/K, 27•

State of Matter	Enthalpy of Formation		Entropy of Formation		Gibbs Free Energy	
	(kcal/mol)	(kJ/mol)	(cal/K)	(J/K)	(kcal/mol)	(kJ/mol)
(s)	0	0	9.04	37.82336	0	0
(g)	90.4	378.2336	39.90	166.9416	81.2	339.7408

Video

top

Video on palladium from the University of Nottingham's periodicvideos.com

Isotopes

top

Nuclide	Mass	Half-Life	Nuclear Spin
^{91}Pd	90.94911(61)#	10# ms [>1.5 •]	7/2+#

^{92}Pd	91.94042(54)#	1.1(3) s [0.7(+4-2) s]	0+
^{93}Pd	92.93591(43)#	1.07(12) s	(9/2+)
^{94}Pd	93.92877(43)#	9.0(5) s	0+
^{95}Pd	94.92469(43)#	10# s	9/2+#
^{96}Pd	95.91816(16)	122(2) s	0+
^{97}Pd	96.91648(32)	3.10(9) min	5/2+#
^{98}Pd	97.912721(23)	17.7(3) min	0+
^{99}Pd	98.911768(16)	21.4(2) min	(5/2)+
^{100}Pd	99.908506(12)	3.63(9) d	0+
^{101}Pd	100.908289(19)	8.47(6) h	5/2+
^{102}Pd	101.905609(3)	STABLE	0+
^{103}Pd	102.906087(3)	16.991(19) d	5/2+
^{104}Pd	103.904036(4)	STABLE	0+
^{105}Pd	104.905085(4)	STABLE	5/2+
^{106}Pd	105.903486(4)	STABLE	0+
^{107}Pd	106.905133(4)	6.5(3)E+6 a	5/2+
^{108}Pd	107.903892(4)	STABLE	0+
^{109}Pd	108.905950(4)	13.7012(24) h	5/2+
^{110}Pd	109.905153(12)	STABLE [>600E+15 a]	0+
^{111}Pd	110.907671(12)	23.4(2) min	5/2+
^{112}Pd	111.907314(19)	21.03(5) h	0+
^{113}Pd	112.91015(4)	93(5) s	(5/2+)
^{114}Pd	113.910363(25)	2.42(6) min	0+
^{115}Pd	114.91368(7)	25(2) s	(5/2+)#
^{116}Pd	115.91416(6)	11.8(4) s	0+
^{117}Pd	116.91784(6)	4.3(3) s	(5/2+)
^{118}Pd	117.91898(23)	1.9(1) s	0+

^{119}Pd	118.92311(32)#	0.92(13) s	
^{120}Pd	119.92469(13)	0.5(1) s	0+
^{121}Pd	120.92887(54)#	400# ms [>300 ns]	
^{122}Pd	121.93055(43)#	300# ms [>300 ns]	0+
^{123}Pd	122.93493(64)#	200# ms [>300 ns]	
^{124}Pd	123.93688(54)#	100# ms [>300 ns]	0+

Values marked # are not purely derived from experimental data, but at least partly from systematic trends. Spins with weak assignment arguments are enclosed in parentheses. [5]

Reactions

top

Composition

top

Earth: Crust: 0.015 mg/kg = 0.0000015 % [6]

Compounds

top

palladium (II) acetate	palladium (II) nitrate	palladium (II) trifluoroacetate
palladium (II) bromide	palladium (II) oxide	palladium (IV) fluoride
palladium (II) chloride	palladium (II) selenide	palladium (IV) oxide
palladium (II) cyanide	palladium (II) sulfate	palladium (IV) selenide
palladium (II) fluoride	palladium (II) sulfide	palladium (IV) sulfide
palladium (II) iodide	palladium (II) telluride	palladium (IV) telluride

Safety

top

Note: Not every link below has an entry for every element on the periodic table. Sites were selected based on those that had a large number of element and compound entries.

Scorecard's Pollution Information – not an MSDS, but it does provide basic information (among other things) on human heath hazards and industrial uses.

Although not truly an MSDS, Oxford University's Physical and Theoretical Chemistry Laboratory does provide some basic information.

Iowa State's Department of Chemistry

Languages

top

Afrikaans:	Palladium	Albanian:	Palad	Arabic:	••••••••	Aromanian:	Paladiumu
Basque:	Paladioa	Bosnian:	Paladij	Breton:	Palladiom	Catalan:	Palladi
Chinese:	•	Cornish:	Paladyum	Croatian:	Paladij	Czech:	Palladium
Danish:	Palladium	Dutch:	Palladium	Esperanto:	Paladio	Estonian:	Pallaadium
Faroese:	Palladium	Finnish:	Palladium	French:	Palladium	Friulian:	Paladi
Frisian:	Palladium	Galician:	Paladio	German:	Palladium	Hungarian:	Pall•ium
Icelandic:	Pallad•	Irish Gaelic:	Pallaidiam	Italian:	Palladio	Japanese:	•••••
Kashubian:	Pall•	Latvian:	Palladijs	Lithuanian:	Paladis	Luxembourgian:	Palladium
Malay:	Paladium	Maltese:	Palladjum	Manx Gaelic:	Pallaadjum	Norwegian:	Palladium
Occitan:	Palladi	Polish:	Pallad	Portuguese:	Pal•io	Scottish Gaelic:	Pallaidiam
Slovak:	Pal•ium	Spanish:	Paladio	Sudovian:	Paladijan	Swahili:	Paladi
Swedish:	Palladium	Tajik:	Palladi'	Turkish:	Palladyum	Vietnamese:	Paladi
Welsh:	Paladiwm						

For More Information

top

From Online Periodic Tables:

About.com

American Elements

Chemical & Engineering News

Chemical Elements

ChemGlobe

Chemicool

Environmental Chemistry

Eni Generalic

HyperPhysics from Georgia State University's Department of Physics and Astronomy

InfoPlease

Lenntech

Los Alamos National Laboratory

Physics Department of the University of Coimbra

Qivx Inc.

Royal Society of Chemistry's Visual Elements

Schenectady County Community College

Thomas Jefferson Lab National Accelerator Facility

WebElements

Wikipedia

X-ray properties: Carlo Segre from IIT

Sources

top

(1) - Lide, David R. *CRC Handbook of Chemistry and Physics*, 83rd ed.; CRC Press: Boca Raton, FL, 2002; p 4-22.

(2) - Lide, David R. CRC Handbook; CRC Press: Boca Raton, FL, 2002; p 4-132.

(3) - Speight, James. *Lange's Handbook of Chemistry*, 16th ed.; McGraw-Hill Professional: Boston, MA, 2006,, 2004; p 1-132.

(4) - Lide, David R. *CRC Handbook of Chemistry and Physics*, 83rd ed.; CRC Press: Boca Raton, FL, 2002; p 10-178 - 10-180.

(5) - Atomic Mass Data Center. http://amdc.in2p3.fr/web/nubase_en.html (accessed July 14, 2009).

(6) - Lide, David R. *CRC Handbook of Chemistry and Physics*, 83rd ed.; CRC Press: Boca Raton, FL, 2002; p 14-17.

PALLADIUM

Back to the Periodic Table

Home

Site designed and maintained by Mr. Everett.

Last update: Thursday, August 06, 2009