Krypton

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Krypton (from Greek: *κρυπτός kryptos* "the hidden one") is a chemical element with symbol **Kr** and atomic number 36. It is a member of group 18 (noble gases) elements. A colorless, odorless, tasteless noble gas, krypton occurs in trace amounts in the atmosphere and is often used with other rare gases in fluorescent lamps. With rare exceptions, krypton is chemically inert.

Krypton, like the other noble gases, is used in lighting and photography. Krypton light has many spectral lines, and krypton plasma is useful in bright, high-powered gas lasers (krypton ion and excimer lasers), each of which resonates and amplifies a single spectral line. Krypton fluoride also makes a useful laser. From 1960 to 1983, the official length of a meter was defined by the 605 nm wavelength of the orange spectral line of krypton-86, because of the high power and relative ease of operation of krypton discharge tubes.

Characteristics

Krypton is characterized by several sharp emission lines (spectral signatures) the strongest being green and yellow.[14] Krypton is one of the products of uranium fission.[15] Solid krypton is white and has a face-centered cubic crystal structure, which is a common property of all noble gases (except helium, with a hexagonal close-packed crystal structure).

Isotopes

Naturally occurring krypton in Earth's atmosphere is composed of six stable isotopes. In addition, about thirty unstable isotopes and isomers are known.[16] ^{81}Kr, the product of atmospheric reactions, is produced with the other naturally occurring isotopes of krypton. Being radioactive, it has a half-life of 230,000 years. Krypton is highly volatile and does not stay in solution in near-surface water, but ^{81}Kr has been used for dating old (50,000–800,000 years) groundwater.[17]

Krypton, $_{36}$Kr

A krypton-filled discharge tube glowing white

Spectral lines of krypton

General properties

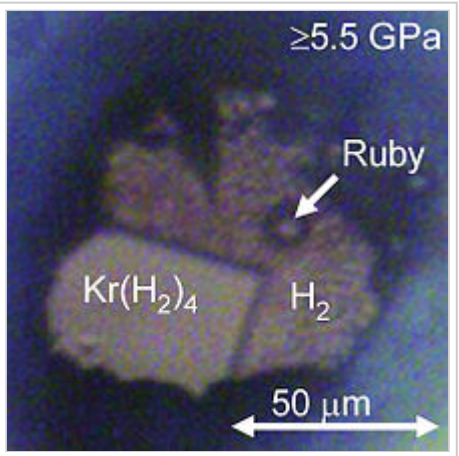
Name, symbol	krypton, Kr
Appearance	colorless gas, exhibiting a whitish glow in an electric field

Krypton in the periodic table

Atomic number (Z)	36
Group, block	group 18 (noble gases), p-block
Period	period 4
Element category	□ noble gas
Standard atomic weight (±) (A_r)	83.798(2)[1]
Electron configuration	[Ar] $3d^{10}$ $4s^2$ $4p^6$
per shell	2, 8, 18, 8

^{85}Kr is an inert radioactive noble gas with a half-life of 10.76 years. It is produced by the fission of uranium and plutonium, such as in nuclear bomb testing and nuclear reactors. ^{85}Kr is released during the reprocessing of fuel rods from nuclear reactors. Concentrations at the North Pole are 30% higher than at the South Pole due to convective mixing.[18]

Chemistry



$Kr(H_2)_4$ and H_2 solids formed in a diamond anvil cell.[19]

Like the other noble gases, krypton is highly chemically unreactive. In fact, before the 1960s, no noble gas compounds had been synthesized.[20]

However, following the first successful synthesis of xenon compounds in 1962, synthesis of krypton difluoride (KrF_2) was reported in 1963. In the same year, KrF_4 was reported by Grosse, *et al.*,[21] but was subsequently shown to be a mistaken identification.[22] Under extreme conditions, krypton reacts with fluorine to form KrF_2 according to the following equation:

$$Kr + F_2 \rightarrow KrF_2$$

Compounds with krypton bonded to atoms other than fluorine have also been discovered. There are also unverified reports of a barium salt of a krypton oxoacid.[23] $ArKr^+$ and KrH^+ polyatomic ions have been investigated and there is evidence for KrXe or $KrXe^+$.[24]

The reaction of KrF_2 with $B(OTeF_5)_3$ produces an unstable compound, $Kr(OTeF_5)_2$, that contains a krypton-oxygen bond. A krypton-nitrogen bond is found in the cation $[HC{\equiv}N–Kr–F]^+$, produced by the reaction of KrF_2 with $[HC{\equiv}NH]^+[AsF_6^-]$ below −50 °C.[25][26] HKrCN and $HKrC{\equiv}CH$ (krypton hydride-cyanide and hydrokryptoacetylene) were reported to be stable up to 40 K.[20]

Physical properties

Phase	gas
Melting point	115.78 K (−157.37 °C, −251.27 °F)
Boiling point	119.93 K (−153.415 °C, −244.147 °F)
Density at stp (0 °C and 101.325 kPa)	3.749 g/L
when liquid, at b.p.	2.413 g/cm3[2]
Triple point	115.775 K, 73.53 kPa[3][4]
Critical point	209.48 K, 5.525 MPa[4]
Heat of fusion	1.64 kJ/mol
Heat of vaporization	9.08 kJ/mol
Molar heat capacity	20.95[5] J/(mol·K)

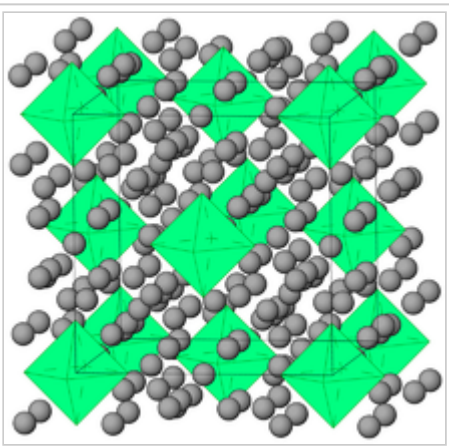
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	59	65	74	84	99	120

Atomic properties

Oxidation states	2, 1, **0** (rarely more than 0; unknown oxide)
Electronegativity	Pauling scale: 3.00
Ionization energies	1st: 1350.8 kJ/mol 2nd: 2350.4 kJ/mol 3rd: 3565 kJ/mol
Covalent radius	116±4 pm
Van der Waals radius	202 pm

Miscellanea



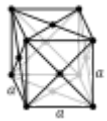
Structure of $Kr(H_2)_4$. Krypton octahedra (green) are surrounded by randomly oriented hydrogen molecules.[19]

Krypton hydride ($Kr(H_2)_4$) crystals can be grown at pressures above 5 GPa. They have a face-centered cubic structure where krypton octahedra are surrounded by randomly oriented hydrogen molecules.[19]

Recently, Zaleski-Ejgierd et al. predicted that a whole new class of krypton compounds – krypton oxides – should stabilize thermodynamically at elevated pressures. In particular, krypton monoxide (KrO) should form spontaneously from a mixture of the pure elements at approximately 285 GPa (2.85 million atmospheres). In it krypton atoms are expected to form strong covalent bonds with the oxygen atoms.[27]

Natural occurrence

Earth has retained all of the noble gases that were present at its formation except helium. Krypton's concentration in the atmosphere is about 1 ppm. It can be extracted from liquid air by fractional distillation.[28] The amount of krypton in space is uncertain, because measurement is derived from meteoric activity and solar winds. The first measurements suggest an abundance of krypton in space.[29]

Crystal structure	face-centered cubic (fcc) 
Speed of sound	(gas, 23 °C) 220 $m \cdot s^{-1}$ (liquid) 1120 m/s
Thermal conductivity	9.43×10^{-3} W/(m·K)
Magnetic ordering	diamagnetic[6]
CAS Number	7439-90-9
History	
Discovery and first isolation	William Ramsay and Morris Travers (1898)
Most stable isotopes of krypton	

Source

- Wikipedia: Krypton (https://en.wikipedia.org/wiki/Krypton)

iso	NA	half-life	DM	DE (MeV)	DP
^{78}Kr	0.36%	is stable with 42 neutrons			
^{79}Kr	syn	35.04 h	ε	–	^{79}Br
			β^+	0.604	^{79}Br
			γ	0.26, 0.39, 0.60	–
^{80}Kr	2.29%	is stable with 44 neutrons			
^{81}Kr	trace	2.29×10^5 y	ε	–	^{81}Br
			γ	0.281	–
^{82}Kr	11.59%	is stable with 46 neutrons			
^{83}Kr	11.50%	is stable with 47 neutrons			
^{84}Kr	56.99%	is stable with 48 neutrons			
^{85}Kr	syn	10.756 y	β^-	0.687	^{85}Rb
^{86}Kr	17.28%	is stable with 50 neutrons			