Lutetium

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Lutetium is a chemical element with symbol **Lu** and atomic number 71. It is a silvery white metal, which resists corrosion in dry, but not in moist air. It is the last element in the lanthanide series, and is traditionally counted among the rare earths. It is sometimes considered the first element of the 6th-period transition metals, although lanthanum is more often considered as such instead of lutetium.

Lutetium was independently discovered in 1907 by French scientist Georges Urbain, Austrian mineralogist Baron Carl Auer von Welsbach, and American chemist Charles James. All of these researchers found lutetium as an impurity in the mineral ytterbia, which was previously thought to consist entirely of ytterbium. The dispute on the priority of the discovery occurred shortly after, with Urbain and Welsbach accusing each other of publishing results influenced by the published research of the other; the naming honor went to Urbain, as he had published his results earlier. He chose the name lutecium for the new element, but in 1949 the spelling of element 71 was changed to lutetium. In 1909, the priority was finally granted to Urbain and his names were adopted as official ones; however, the name **cassiopeium** (or later **cassiopium**) for element 71 proposed by Welsbach was used by many German scientists until the 1950s.

Lutetium is not a particularly abundant element, although it is significantly more common than silver in the earth's crust. It has few specific uses. Lutetium-176 is a relatively abundant (2.5%) radioactive isotope with a half-life of about 38 billion years used to determine the age of meteorites. Lutetium usually occurs in association with the element yttrium and is sometimes used in metal alloys and as a catalyst in various chemical reactions. ^{177}Lu-DOTA-TATE is used for radionuclide therapy (see Nuclear medicine) on neuroendocrine tumours. Lutetium has the highest Brinell hardness of any lanthanide, at 890–1300 MPa.[3]

Lutetium, $_{71}$Lu

General properties	
Name, symbol	lutetium, Lu
Appearance	silvery white
Lutetium in the periodic table	
Atomic number (Z)	71
Group, block	group n/a, d-block
Period	period 6
Element category	□ lanthanide, sometimes considered a transition metal
Standard atomic weight (±) (A_r)	174.9668(1)[1]
Electron configuration	[Xe] $6s^2$ $4f^{14}$ $5d^1$
per shell	2, 8, 18, 32, 9, 2
Physical properties	
Phase	solid
Melting point	1925 K (1652 °C, 3006 °F)
Boiling point	3675 K (3402 °C, 6156 °F)

Characteristics

Physical properties

A lutetium atom has 71 electrons, arranged in the configuration [Xe] $4f^{14}5d^{1}6s^{2}$.[4] When entering a chemical reaction, the atom loses its two outermost electrons and the single 5d-electron. The lutetium atom is the smallest among the lanthanide atoms, due to the lanthanide contraction,[5] and as a result lutetium has the highest density, melting point, and hardness of the lanthanides.[6]

Chemical properties and compounds

Lutetium's compounds always contain the element in the oxidation state +3. Aqueous solutions of most lutetium salts are colorless and form white crystalline solids upon drying, with the common exception of the iodide. The soluble salts, such as nitrate, sulfate and acetate form hydrates upon crystallization. The oxide, hydroxide, fluoride, carbonate, phosphate and oxalate are insoluble in water.[7]

Lutetium metal is slightly unstable in air at standard conditions, but it burns readily at 150 °C to form lutetium oxide. The resulting compound is known to absorb water and carbon dioxide, and may be used to remove vapors of these compounds from closed atmospheres.[8] Similar observations are made during reaction between lutetium and water (slow when cold and fast when hot); lutetium hydroxide is formed in the reaction.[9] Lutetium metal is known to react with the four lightest halogens to form trihalides; all of them (except the fluoride) are soluble in water.

Lutetium dissolves readily in weak acids[8] and dilute sulfuric acid to form solutions containing the colorless lutetium ions, which are coordinated by between seven and nine water molecules, the average being $[Lu(H_2O)_{8.2}]^{3+}$.[10]

$$2\ Lu + 3\ H_2SO_4 \rightarrow 2\ Lu^{3+} + 3\ SO_4^{2-} + 3\ H_2\uparrow$$

Isotopes

Lutetium occurs on the Earth in form of two isotopes: lutetium-175 and lutetium-176. Out of these two, only the former is stable, making the element monoisotopic. The latter one, lutetium-176, decays via beta decay with a half-life of 3.78×10^{10}

Density near r.t.	9.841 g/cm^3
when liquid, at m.p.	9.3 g/cm^3
Heat of fusion	ca. 22 kJ/mol
Heat of vaporization	414 kJ/mol
Molar heat capacity	26.86 J/(mol·K)

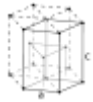
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	1906	2103	2346	(2653)	(3072)	(3663)

Atomic properties

Oxidation states	**3**, 2, 1 (a weakly basic oxide)
Electronegativity	Pauling scale: 1.27
Ionization energies	1st: 523.5 kJ/mol 2nd: 1340 kJ/mol 3rd: 2022.3 kJ/mol
Atomic radius	empirical: 174 pm
Covalent radius	187±8 pm

Miscellanea

Crystal structure	hexagonal close-packed (hcp) 
Thermal expansion	poly: 9.9 µm/(m·K) (at r.t.)
Thermal conductivity	16.4 W/(m·K)
Electrical resistivity	poly: 582 nΩ·m (at r.t.)
Magnetic ordering	paramagnetic[2]
Young's modulus	68.6 GPa

years; it makes up about 2.5% of natural lutetium.[11] To date, 32 synthetic radioisotopes of the element have been characterized, ranging in mass from 149.973 (lutetium-150) to 183.961 (lutetium-184); the most stable such isotopes are lutetium-174 with a half-life of 3.31 years, and lutetium-173 with a half-life of 1.37 years.[11] All of the remaining radioactive isotopes have half-lives that are less than 9 days, and the majority of these have half-lives that are less than half an hour.[11] Isotopes lighter than the stable lutetium-175 decay via electron capture (to produce isotopes of ytterbium), with some alpha and positron emission; the heavier isotopes decay primarily via beta decay, producing hafnium isotopes.[11]

The element also has 42 nuclear isomers, with masses of 150, 151, 153–162, 166–180 (not every mass number corresponds to only one isomer). The most stable of them are lutetium-177m, with half-life of 160.4 days and lutetium-174m, with half-life of 142 days; this is longer than half-lives of the ground states of all radioactive lutetium isotopes, except only for lutetium-173, 174, and 176.[11]

Source

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

Shear modulus	27.2 GPa
Bulk modulus	47.6 GPa
Poisson ratio	0.261
Vickers hardness	755–1160 MPa
Brinell hardness	890–1300 MPa
CAS Number	7439-94-3
	History
Naming	after *Lutetia*, Latin for: Paris, in the Roman era
Discovery	Carl Auer von Welsbach and Georges Urbain (1906)
First isolation	Carl Auer von Welsbach (1906)
Named by	Georges Urbain (1906)

Most stable isotopes of lutetium

iso	NA	half-life	DM	DE (MeV)	DP
^{173}Lu	syn	1.37 y	ε	0.671	^{173}Yb
^{174}Lu	syn	3.31 y	ε	1.374	^{174}Yb
^{175}Lu	97.401%	is stable with 104 neutrons			
^{176}Lu	2.599%	3.78×10^{10} y	β^-	1.193	^{176}Hf