Erbium

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Erbium is a chemical element in the lanthanide series, with symbol **Er** and atomic number 68. A silvery-white solid metal when artificially isolated, natural erbium is always found in chemical combination with other elements on Earth. As such, it is a rare earth element which is associated with several other rare elements in the mineral gadolinite from Ytterby in Sweden, where yttrium, ytterbium, and terbium were discovered.

Erbium's principal uses involve its pink-colored Er^{3+} ions, which have optical fluorescent properties particularly useful in certain laser applications. Erbium-doped glasses or crystals can be used as optical amplification media, where Er^{3+} ions are optically pumped at around 980 or 1480 nm and then radiate light at 1530 nm in stimulated emission. This process results in an unusually mechanically simple laser optical amplifier for signals transmitted by fiber optics. The 1550 nm wavelength is especially important for optical communications because standard single mode optical fibers have minimal loss at this particular wavelength.

In addition to optical fiber amplifier-lasers, a large variety of medical applications (i.e. dermatology, dentistry) rely on the erbium ion's 2940 nm emission (see Er:YAG laser), which is highly absorbed in water in tissues, making its effect very superficial. Such shallow tissue deposition of laser energy is helpful in laser surgery, and for the efficient production of steam which produces enamel ablation by common types of dental laser.

Characteristics

Physical properties

A trivalent element, pure erbium metal is malleable (or easily shaped), soft yet stable in air, and does not oxidize as quickly as some other rare-earth metals. Its salts are rose-colored, and the element has characteristic sharp absorption spectra bands in visible light, ultraviolet, and near infrared. Otherwise it looks

Erbium, $_{68}$Er

General properties	
Name, symbol	erbium, Er
Appearance	silvery white
Erbium in the periodic table	
Atomic number (*Z*)	68
Group, block	group n/a, f-block
Period	period 6
Element category	lanthanide
Standard atomic weight (±) (A_r)	167.259(3)[1]
Electron configuration	[Xe] $4f^{12}$ $6s^2$
per shell	2, 8, 18, 30, 8, 2
Physical properties	
Phase	solid
Melting point	1802 K (1529 °C, 2784 °F)

Erbium(III)chloride in sunlight, showing some pink fluorescence of Er^{+3} from natural ultraviolet.

much like the other rare earths. Its sesquioxide is called erbia. Erbium's properties are to a degree dictated by the kind and amount of impurities present. Erbium does not play any known biological role, but is thought to be able to stimulate metabolism.[2]

Erbium is ferromagnetic below 19 K, antiferromagnetic between 19 and 80 K and paramagnetic above 80 K.[3]

Erbium can form propeller-shaped atomic clusters Er_3N, where the distance between the erbium atoms is 0.35 nm. Those clusters can be isolated by encapsulating them into fullerene molecules, as confirmed by transmission electron microscopy.[4]

Chemical properties

Erbium metal tarnishes slowly in air and burns readily to form erbium(III) oxide:

$$4\ Er + 3\ O_2 \rightarrow 2\ Er_2O_3$$

Erbium is quite electropositive and reacts slowly with cold water and quite quickly with hot water to form erbium hydroxide:

$$2\ Er\ (s) + 6\ H_2O\ (l) \rightarrow 2\ Er(OH)_3\ (aq) + 3\ H_2\ (g)$$

Erbium metal reacts with all the halogens:

$$2\ Er\ (s) + 3\ F_2\ (g) \rightarrow 2\ ErF_3\ (s)\ [pink]$$
$$2\ Er\ (s) + 3\ Cl_2\ (g) \rightarrow 2\ ErCl_3\ (s)\ [violet]$$
$$2\ Er\ (s) + 3\ Br_2\ (g) \rightarrow 2\ ErBr_3\ (s)\ [violet]$$
$$2\ Er\ (s) + 3\ I_2\ (g) \rightarrow 2\ ErI_3\ (s)\ [violet]$$

Boiling point	3141 K (2868 °C, 5194 °F)
Density near r.t.	9.066 g/cm^3
when liquid, at m.p.	8.86 g/cm^3
Heat of fusion	19.90 kJ/mol
Heat of vaporization	280 kJ/mol
Molar heat capacity	28.12 J/(mol·K)

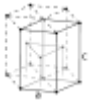
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	1504	1663	(1885)	(2163)	(2552)	(3132)

Atomic properties

Oxidation states	**3**, 2, 1 (a basic oxide)
Electronegativity	Pauling scale: 1.24
Ionization energies	1st: 589.3 kJ/mol 2nd: 1150 kJ/mol 3rd: 2194 kJ/mol
Atomic radius	empirical: 176 pm
Covalent radius	189±6 pm

Miscellanea

Crystal structure	hexagonal close-packed (hcp) 
Speed of sound thin rod	2830 m/s (at 20 °C)
Thermal expansion	poly: 12.2 µm/(m·K) (r.t.)
Thermal conductivity	14.5 W/(m·K)
Electrical resistivity	poly: 0.860 µΩ·m (r.t.)
Magnetic ordering	paramagnetic at 300 K

Erbium dissolves readily in dilute sulfuric acid to form solutions containing hydrated Er(III) ions, which exist as rose red $[Er(OH_2)_9]^{3+}$ hydration complexes:[5]

$$2\ Er\ (s) + 3\ H_2SO_4\ (aq) \rightarrow 2\ Er^{3+}\ (aq) + 3\ SO_4^{2-}\ (aq) + 3\ H_2\ (g)$$

Isotopes

Naturally occurring erbium is composed of 6 stable isotopes, ^{162}Er, ^{164}Er, ^{166}Er, ^{167}Er, ^{168}Er, and ^{170}Er with ^{166}Er being the most abundant (33.503% natural abundance). 29 radioisotopes have been characterized, with the most stable being ^{169}Er with a half-life of 9.4 d, ^{172}Er with a half-life of 49.3 h, ^{160}Er with a half-life of 28.58 h, ^{165}Er with a half-life of 10.36 h, and ^{171}Er with a half-life of 7.516 h. All of the remaining radioactive isotopes have half-lives that are less than 3.5 h, and the majority of these have half-lives that are less than 4 minutes. This element also has 13 meta states, with the most stable being ^{167m}Er with a half-life of 2.269 s.[6]

The isotopes of erbium range in atomic weight from 142.9663 u (^{143}Er) to 176.9541 u (^{177}Er). The primary decay mode before the most abundant stable isotope, ^{166}Er, is electron capture, and the primary mode after is beta decay. The primary decay products before ^{166}Er are element 67 (holmium) isotopes, and the primary products after are element 69 (thulium) isotopes.[6]

Source

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

Young's modulus	69.9 GPa
Shear modulus	28.3 GPa
Bulk modulus	44.4 GPa
Poisson ratio	0.237
Vickers hardness	430–700 MPa
Brinell hardness	600–1070 MPa
CAS Number	7440-52-0
History	
Naming	after Ytterby (Sweden), where it was mined
Discovery	Carl Gustaf Mosander (1842)

Most stable isotopes of erbium

iso	NA	half-life	DM	DE (MeV)	DP
^{160}Er	syn	28.58 h	ε	0.330	^{160}Ho
^{162}Er	0.139%	is stable with 94 neutrons			
^{164}Er	1.601%	is stable with 96 neutrons			
^{165}Er	syn	10.36 h	ε	0.376	^{165}Ho
^{166}Er	33.503%	is stable with 98 neutrons			
^{167}Er	22.869%	is stable with 99 neutrons			
^{168}Er	26.978%	is stable with 100 neutrons			
^{169}Er	syn	9.4 d	β−	0.351	^{169}Tm
^{170}Er	14.910%	is stable with 102 neutrons			
^{171}Er	syn	7.516 h	β−	1.490	^{171}Tm
^{172}Er	syn	49.3 h	β−	0.891	^{172}Tm