The element

Symbol	Ce	
Element name	Cerium	
Periodic table row	Lanthanides	
Periodic table column	Column 3	
Atomic number	58	
Atomic weight	140	kg/kmol
Date of discovery ("-" = BCE)	1803	
Group	Lanthanides	

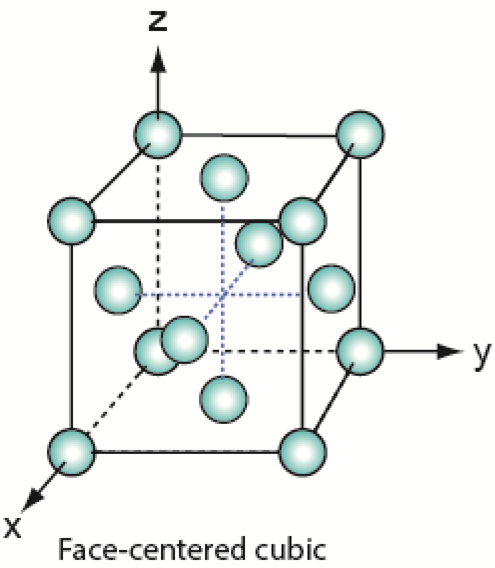
Electronic structure

Electronic structure	[Xe] 4f1 5d1 6s2	
Valence	4	
First ionization energy	5,54	eV
Second ionization energy	10,9	eV
Electronegativity (Pauling)	1,12	

Structure

Crystal structure	Cubic: Face centered

Crystal structure image



Space group	Fm3m	
Lattice parameter, a	0,485	nm
Atomic radius	0,183	nm
Atomic volume	2,82e-29	m^3
Molar volume	0,017	m^3/kmol
State at 300K (Metal / Non-metal)	Metal	
Phase at 300K (Solid / Liquid / Gas)	Solid	

Geo-economic data

Typical exploited ore grade	1,47	-	1,63	%
Minimum economic ore grade	0,1	-	3	%

Abundance in the Earth's crust	43	-	66,5	ppm
Abundance in seawater	1,2e-6	-	1,5e-6	ppm
Annual world production	2,95e4			tonne/yr
World reserves	1,4e8			tonne

Main mining areas (metric tonnes per year)

Mine production of rare earth oxide:

Australia, 2e3
Brazil, 140
China, 100e3
India, 2.9e3
Malaysia, 100
Russia, 2.4e3
United States, 4e3
Vietnam, 220

Eco properties

Water usage, pure element	52,4	-	57,9	l/kg

Critical materials information

In EU Critical list?	✓	
In US Critical list?	✓	
Abundance risk level	Medium	
Environmental country risk Herfindahl-Hirschman Index (HHI)	4,09	
Environmental country risk level	Very high	
Sourcing and geopolitical risk Herfindahl-Hirschman Index (HHI	5,57	
Sourcing and geopolitical risk level	Very high	
Price volatility	6,25e3	%
Price volatility risk	Very high	

Physical properties

Density at 300K	8,24e3	kg/m^3

Mechanical properties

Young's modulus at 300K	30	GPa
Shear modulus at 300K	8,5	GPa
Bulk modulus at 300K	26,2	GPa
Poisson's ratio	0,14	

Thermal properties

Melting temperature	799	°C
Boiling point	3,43e3	°C
Heat of fusion	5,46	kJ/mol
Heat of vaporization	414	kJ/mol
Cohesive energy	410	kJ/mol
Thermal expansion coefficient at 300K	8,5	µstrain/°C
Specific heat capacity	190	J/kg.°C

Surface energies

Surface energy, liquid	0,74	J/m^2

Electrical and superconducting properties

Electrical resistivity at 300K	73	µohm.cm
T - dependence of resistivity	8,7e-4	/°C

Magnetic properties

Magnetic classification	Antiferromagnetic
Magnetic susceptibility	0,00149

Nuclear properties

Neutron absorption cross section (0.025 eV)	0,63	Barns
Neutron scattering cross section (0.025 eV)	4,7	Barns
Binding energy per nucleon	8,38e3	keV

Principal uses and substitutes

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25% used to polish precision optics.
Alternative: iron oxide. Quality: adequate.

19% used as a glass additive for decolorization and as a dopant.
Alternative: selenium. Quality: adequate.

16% used in catalytic converters as a cerium oxide coating on ceramic.
Alternative: lanthanum. Quality: adequate.

14% used in metallurgy to create aluminum, magnesium and iron alloys.
Alternative: magnesium. Quality: adequate.

10% used for battery alloys in nickel-metal hydride batteries using nickel and mischmetal.
Alternative: lithium-ion batteries. Quality: good.

16% other uses including in arc welding and carbon arc lighting.
Alternative: N/A.

Notes

1. Goonan TG (2011) Rare Earth Elements - End Use and Recyclability. in Scientific Investigations Report 2011-5094 (U.S. Geological Survey, Reston, Virginia).
2. Schüler D, Buchert M, Liu R, Dittrich S, & Merz C (2011) Study on Rare Earths and Their Recycling. (Darmstadt: Öko-Institut e.V).
3. Gupta CK & Krishnamurthy N (2005) Extractive Metallurgy of Rare Earths (CRC Press, Boca Raton, Florida).
4. USBM (1985) Mineral Facts and Problems (United States Bureau of Mines).
5. Bleiwas DI (2013) Potential for Recovery of Cerium Contained in Automotive Catalytic Converters (Open-File Report 2013-1037, U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia).

Notes

Energy conversion factors

* To convert energy from kJ/mol to kJ/kg multiply by 1000 / (Atomic weight in kg / kmol).

* To convert energy from kJ/mol to J/atom multiply by 1000 / (Avogadro's number).
Avogadro's number is the number of atoms or molecules in a kmol, 6.02 x 10^23.

* To convert energy from kJ/mol to kJ/m^3, multiply by 1000/(Molar volume in m^3/kmol)

* The energy unit eV is a unit of convenience. The SI unit is J (1 eV = 1.6 x 10^-19 J).

Liens

Reference