

Scandium

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Scandium is a chemical element with symbol **Sc** and atomic number 21. A silvery-white metallic d-block element, it has historically been sometimes classified as a rare earth element, together with yttrium and the lanthanides. It was discovered in 1879 by spectral analysis of the minerals euxenite and gadolinite from Scandinavia.

Scandium is present in most of the deposits of rare earth and uranium compounds, but it is extracted from these ores in only a few mines worldwide. Because of the low availability and the difficulties in the preparation of metallic scandium, which was first done in 1937, applications for scandium were not developed until the 1970s. The positive effects of scandium on aluminium alloys were discovered in the 1970s, and its use in such alloys remains its only major application. The global trade of scandium oxide is about 10 tonnes per year.

The properties of scandium compounds are intermediate between those of aluminium and yttrium. A diagonal relationship exists between the behavior of magnesium and scandium, just as there is between beryllium and aluminium. In the chemical compounds of the elements in group 3, the predominant oxidation state is +3.

Properties

Chemical characteristics of the element

Scandium is a soft metal with a silvery appearance. It develops a slightly yellowish or pinkish cast when oxidized by air. It is susceptible to weathering and dissolves slowly in most dilute acids. It does not react with a 1:1 mixture of nitric acid (HNO₃) and 48% hydrofluoric acid (HF), possibly due to the formation of an impermeable passive layer. Scandium turnings ignite in air with a brilliant yellow flame to form scandium(III) oxide.^[4]

Isotopes

Scandium, ²¹Sc



General properties

| | |
|---------------------|---------------|
| Name, symbol | scandium, Sc |
| Appearance | silvery white |

Scandium in the periodic table

| | |
|---|--------------------------------------|
| Atomic number (<i>Z</i>) | 21 |
| Group, block | group 3, d-block |
| Period | period 4 |
| Element category | ☐ transition metal |
| Standard atomic weight (<i>A</i> _r) | 44.955908(5) ^[1] |
| Electron configuration | [Ar] 3d ¹ 4s ² |
| per shell | 2, 8, 9, 2 |

Physical properties

| | |
|----------------------|---------------------------|
| Phase | solid |
| Melting point | 1814 K (1541 °C, 2806 °F) |
| Boiling point | 3109 K (2836 °C, 5136 °F) |

In nature, scandium is found exclusively as the isotope ⁴⁵Sc, which has a nuclear spin of 7/2. Thirteen radioisotopes have been characterized with the most stable being ⁴⁶Sc, which has a half-life of 83.8 days; ⁴⁷Sc, 3.35 days; the positron emitter ⁴⁴Sc, 4 h; and ⁴⁸Sc, 43.7 hours. All of the remaining radioactive isotopes have half-lives less than 4 hours, and the majority of these have half-lives less than 2 minutes. This element also has five meta states, with the most stable being ^{44m}Sc (t_{1/2} = 58.6 h).^[5]

The isotopes of scandium range from ³⁶Sc to ⁶⁰Sc. The primary decay mode at masses lower than the only stable isotope, ⁴⁵Sc, is electron capture, and the primary mode at masses above it is beta emission. The primary decay products at atomic weights below ⁴⁵Sc are calcium isotopes and the primary products from higher atomic weights are titanium isotopes.^[5]

Occurrence

In Earth's crust, scandium is not rare. Estimates vary from 18 to 25 ppm, which is comparable to the abundance of cobalt (20–30 ppm). Scandium is only the 50th most common element on Earth (35th most abundant in the crust), but it is the 23rd most common element in the Sun.^[6] However, scandium is distributed sparsely and occurs in trace amounts in many minerals.^[7] Rare minerals from Scandinavia^[8] and Madagascar^[9] such as thortveitite, euxenite, and gadolinite are the only known concentrated sources of this element. Thortveitite can contain up to 45% of scandium in the form of scandium(III) oxide.^[8]

The stable form of scandium is created in supernovas via the r-process.^[10]

Source

- Wikipedia: Scandium (<https://en.wikipedia.org/wiki/Scandium>)

| | |
|-----------------------------|-------------------------|
| Density near r.t. | 2.985 g/cm ³ |
| when liquid, at m.p. | 2.80 g/cm ³ |
| Heat of fusion | 14.1 kJ/mol |
| Heat of vaporization | 332.7 kJ/mol |
| Molar heat capacity | 25.52 J/(mol·K) |


Vapor pressure

| P (Pa) | 1 | 10 | 100 | 1 k | 10 k | 100 k |
|----------|------|------|--------|--------|--------|--------|
| at T (K) | 1645 | 1804 | (2006) | (2266) | (2613) | (3101) |

Atomic properties

| | |
|-----------------------------|--|
| Oxidation states | 3 , 2, ^[2] 1 ^[3] (an amphoteric oxide) |
| Electronegativity | Pauling scale: 1.36 |
| Ionization energies | 1st: 633.1 kJ/mol 2nd: 1235.0 kJ/mol 3rd: 2388.6 kJ/mol (more) |
| Atomic radius | empirical: 162 pm |
| Covalent radius | 170±7 pm |
| Van der Waals radius | 211 pm |

Miscellanea

| | |
|-------------------------------|---|
| Crystal structure | hexagonal close-packed (hcp) <div></div> |
| Thermal expansion | α, poly: 10.2 μm/(m·K) (at r.t.) |
| Thermal conductivity | 15.8 W/(m·K) |
| Electrical resistivity | α, poly: 562 nΩ·m (at r.t., calculated) |
| Magnetic ordering | paramagnetic |

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| | |
|-------------------------|--------------|
| Young's modulus | 74.4 GPa |
| Shear modulus | 29.1 GPa |
| Bulk modulus | 56.6 GPa |
| Poisson ratio | 0.279 |
| Brinell hardness | 736–1200 MPa |
| CAS Number | 7440-20-2 |

History

| | |
|--------------------------------------|----------------------------|
| Naming | after Scandinavia |
| Prediction | Dmitri Mendeleev (1871) |
| Discovery and first isolation | Lars Fredrik Nilson (1879) |

Most stable isotopes of scandium

| iso | NA | half-life | DM | DE (MeV) | DP |
|--------------------------|------|----------------------------|----------------|---------------|------------------|
| ^{44m2}Sc | syn | 58.61 h | IT | 0.2709 | ⁴⁴ Sc |
| | | | γ | 1.0, 1.1, 1.1 | ⁴⁴ Sc |
| | | | ε | – | ⁴⁴ Ca |
| ⁴⁵Sc | 100% | is stable with 24 neutrons | | | |
| ⁴⁶Sc | syn | 83.79 d | β [−] | 0.3569 | ⁴⁶ Ti |
| | | | γ | 0.889, 1.120 | – |
| ⁴⁷Sc | syn | 3.3492 d | β [−] | 0.44, 0.60 | ⁴⁷ Ti |
| | | | γ | 0.159 | – |
| ⁴⁸Sc | syn | 43.67 h | β [−] | 0.661 | ⁴⁸ Ti |
| | | | γ | 0.9, 1.3, 1.0 | – |