

Thulium (Tm) - Student Datasheet

Element 69 · Lanthanide · source-reviewed learning reference

Thulium is element 69, a rare lanthanide whose Tm^{3+} optical transitions connect the periodic table to near-infrared lasers and specialized isotope applications.

Quick reference

Atomic number	69
Relative atomic mass	168.934
Electron configuration	[Xe] $4f^{13} 6s^2$
Period / group / block	6 / Lanthanide / f
State context	Bright silvery lanthanide metal
Density	9.32 g/cm ³
Melting / transition	1818 K
Boiling / gas reference	2223 K
Oxidation states	+3, +2
Electronegativity	1.25

Structure & orbitals

Ordinary thulium metal is HCP. Tm-doped laser hosts and isotope source materials have different structures and are kept separate from the elemental lattice.

The displayed $4f_{xyz}$ orbital is one representative real f cubic harmonic. It is not a picture of the whole 4f subshell or the electronic bands in the bulk material.

Phase behavior

At approximately standard pressure, thulium is treated as a solid below 1818 K, liquid between melting and approximately 2223 K, and gas above the boiling reference. The ordinary crystal label applies to the stated material reference; unmodeled solid allotropy is not fabricated.

Five things to remember

- Atomic number 69 means every thulium nucleus has 69 protons.
- Neutral Thulium has the ground-state configuration [Xe] $4f^{13} 6s^2$.
- The representative teaching isotope is ^{169}Tm .
- Thulium laser materials use Tm ions inside a host crystal or glass.
- The ordinary material reference is Hexagonal close-packed (HCP).

Thulium: Real World & Signature Science

Element-specific science, uses and history

Big idea

Thulium laser materials use Tm ions inside a host crystal or glass. The radioactive isotope ^{170}Tm has specialized x-ray-source history, but natural thulium is overwhelmingly stable ^{169}Tm ; isotope-specific wording matters.

Why this element is scientifically distinctive

Explore Tm across the teaching nucleus, isolated-atom orbitals, evidence-aware material structure and temperature/evidence views, then connect those models to uses, isotopes, search-led questions and source-backed context.

Near-infrared lasers	Tm ³⁺ -doped hosts support laser emission near 2 μm and other optical transitions.
Isotope x-ray sources	Reactor-produced ^{170}Tm has been used as a compact x-ray source; this is an isotope-specific application.
Optical research	Tm-doped fibers and crystals are studied for lasers, amplifiers and spectroscopy.
Rare-earth materials	Thulium appears in specialized alloys and compounds where small additions can tune properties.
Isotope boundary	Natural thulium is essentially ^{169}Tm ; artificial ^{170}Tm radioactivity must not be generalized to every thulium sample.

From source material to Thulium applications: high-level material path

1. Thulium is obtained from mineral or metallurgical feedstocks in which it is chemically associated with other elements rather than mined as abundant native metal.
2. Industrial separation and refining produce element-specific compounds or metal feedstock; this guide does not provide operational extraction recipes.
3. The refined material is converted into the particular alloy, compound, doped host or component required by the application.
4. Recycling and recovery depend on the host product, concentration and economics; application materials must not be confused with pure element.

History checkpoints

1879	Per Teodor Cleve isolated thulium oxide while examining erbium-rich rare-earth material in Uppsala.
Name	Thulium was named after Thule, an ancient name associated with the far north.
20th century	High-purity thulium enabled isotope, laser and spectroscopy studies.
Today	Tm remains one of the less abundant lanthanides and is used mainly in specialty optical/isotope contexts.

Use contexts

- ['Near-IR lasers', 'Tm-doped fibers and crystals support useful near-2 μm laser systems.']
- ['Isotope sources', 'Artificial ^{170}Tm has been used in compact x-ray-source applications.']
- ['Spectroscopy', 'Tm ions provide characteristic optical transitions for research and sensing.']
- ['Specialty materials', 'Small Tm additions or compounds are used where specific optical/electronic behavior is needed.']

Thulium: Isotopes, Questions & Evidence

Evidence status and learner self-check

Isotope context

^{169}Tm	Natural isotope	Essentially all natural thulium is stable ^{169}Tm .
^{170}Tm	Artificial radioisotope	Has isotope-specific x-ray-source applications.
Natural thulium	Single-isotope natural element	Natural thulium should not be described as broadly radioactive because an artificial isotope has a use.

Common questions

What is thulium?

Thulium is chemical element 69, symbol Tm, a bright silvery lanthanide metal.

What is thulium used for?

It is used mainly in Tm-doped lasers, optical research and isotope-specific x-ray-source applications.

Where is thulium found?

It occurs at low concentrations with other rare earths in minerals such as monazite and is separated during rare-earth processing.

Who discovered thulium?

Per Teodor Cleve isolated thulium in 1879.

Is thulium a metal?

Yes. It is a lanthanide metal.

Is thulium radioactive?

Natural thulium is essentially stable ^{169}Tm . Artificial radioisotopes such as ^{170}Tm are radioactive and have specialized uses.

Evidence & safety

Atomic identity and reference values are source-reviewed. Material viewers are teaching representations, not crystallographic refinements. Search demand shapes headings and FAQs but never overrides measured/evaluated evidence or element-versus-compound distinctions.

This page is educational. Chemical, occupational, radiological or medical safety decisions require the specific material/isotope, its current safety data and qualified guidance.

Core sources

Royal Society of Chemistry - Thulium - <https://periodic-table.rsc.org/element/69/thulium>

NIST - Atomic Weights and Isotopic Compositions - https://physics.nist.gov/cgi-bin/Compositions/stand_alone.pl

IUPAC - Periodic Table of Elements - <https://iupac.org/what-we-do/periodic-table-of-elements/>