Hafnium (Hf)

Element 72 — Complete Summary

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72
Hf
Hafnium
178.486

Key Properties

Atomic Mass	178.486
Category	Transition Metals
State at 20°C	solid
Melting Point	2233°C
Boiling Point	4600°C
Density	13.31
Electron Config	[Xe] 4f145d26s2
Electronegativity	1.3
Year Discovered	1923
Discovered By	Dirk Coster & George de Hevesy

✨ Did You Know?

1. It was one of the last stable (non-radioactive) elements to be discovered, in 1923.
2. Its chemical properties are so similar to zirconium that it is extremely difficult to separate the two. For this reason, zirconium metal always contains a small amount of hafnium unless it has been highly purified.
3. Hafnium is excellent at absorbing neutrons, so it is used to make control rods for nuclear submarines.
4. It is named after Hafnia, the Latin name for Copenhagen, the city where it was discovered.
5. The filament in plasma cutting torches is often made from hafnium because it can withstand the incredibly high temperatures.

APPEARANCE
Hafnium is a lustrous, silvery, ductile metal.

SUPERHERO PERSONA
"The Zirconium Twin, a hero almost identical to its twin, tasked with controlling nuclear reactions in submarines."

EVERYDAY CONNECTION
Hafnium is found in the control rods in a nuclear submarine's reactor.

POP CULTURE
Hafnium is so similar to zirconium that it was the second-to-last stable element to be discovered.

Overview of Hafnium

Hafnium is a shiny, silvery transition metal with atomic number 72. It is highly resistant to corrosion and can be drawn into wires, making it both durable and workable. Its most distinctive property is its ability to absorb neutrons, which makes it invaluable for nuclear technology. The element is chemically very similar to zirconium and is almost always found mixed with it in nature.

Uses of Hafnium

Hafnium's combination of nuclear, thermal, and electronic properties gives it a wide range of applications:

Nuclear reactors: Hafnium is used to manufacture control rods in nuclear reactors, including those in nuclear submarines, because it is an excellent neutron absorber. These rods regulate and stop the fission process.

High-temperature applications: With a very high melting point (over 2200 °C), hafnium is used in plasma welding torches, rocket nozzles, and high-temperature alloys with iron, titanium, and other metals.

Electronics: Hafnium oxide (HfO_2) is an important insulator in microchips, helping reduce power consumption and allowing devices to become smaller and more efficient.

Catalysts: Hafnium compounds are used as catalysts in chemical reactions, particularly in polymer production.

Natural Occurrence and Production of Hafnium

Hafnium is never found as a pure element in nature. It always occurs mixed with zirconium ores, which typically contain about 5% hafnium. This close chemical similarity made it very difficult to separate and delayed its discovery.

Extraction: Pure hafnium is usually obtained by reducing hafnium tetrachloride ($HfCl_4$) with sodium or magnesium.

First pure sample: The first pure sample of hafnium metal was prepared in 1925 using the iodide process, which decomposed hafnium tetraiodide.

History of Hafnium

Predicted by Mendeleev: Dmitri Mendeleev left a gap below zirconium in his periodic table, correctly predicting hafnium's existence.

1923 – Discovery: Hafnium was identified by George de Hevesy and Dirk Coster at the University of Copenhagen using X-ray spectroscopy. They discovered it in a Norwegian zirconium mineral.

Naming: It was named hafnium after Hafnia, the Latin name for Copenhagen.

Biological Role of Hafnium

Hafnium has no known biological role and is considered to have low toxicity. It does not accumulate significantly in living organisms.