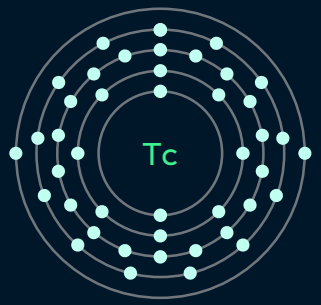
Technetium

tɛk'ni:ʃɪəm



Technetium can form up to 7+ ions!

What seems like a generic silver-grey metal just like any other, but is uniquely synthetic and radioactive – as well as having arguably one of the coolest names.

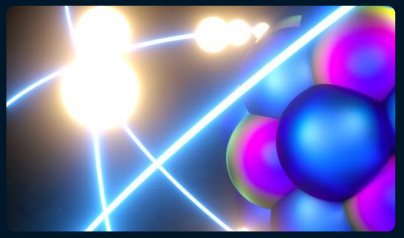
Atomics

43	ATOMIC NUMBER
[98]	RELATIVE MASS
11 g/cm^3	DENSITY
7	GROUP
5	PERIOD
2.8.18.13.2	ELECTRON SHELLS
SOLID	STATE
2157°C	MELTING POINT
4265°C	BOILING POINT

Characteristics

Technetium is the first (lightest) radioactive element with no stable isotopes – which is remarkable, considering that there are no others until promethium at number 61; and only these two before 82, after which all elements have no stable isotopes. It is chemically similar to rhenium, which lies below it in the periodic table, and is not too reactive.

Technetium slowly tarnishes when exposed to air.



Of technetium's 36 discovered isotopes, 29 have half-lives shorter than 30 minutes.

Naturally occurring technetium is exceedingly rare, as even the most stable radioisotope, ^{97}Tc, has a half-life of 4.2 million years – less than a thousandth of the Earth's age. The chances of a single atom of primordial technetium surviving are effectively zero. Only trace amounts are newly produced as the spontaneous fission product of uranium ores. This was why it was so difficult to discover.

Origins

Technetium derives from the Greek τεχνητός, meaning 'artificial'. It was originally called ekamanganese, a temporary name given to it by none other than Dmitri Mendeleev, who had noted a gap in his periodic table below manganese.

The element long perplexed chemists for decades, as they simply could not find it. It was thought that it would be quite easy to discover, given its early position in the periodic table. Numerous reports were published claiming its discovery, but all turned out to be different elements.

It was not until 1937, nearly 70 years after Mendeleev had predicted its existence, that technetium was finally discovered, in Sicily by Italian scientists Carlo Perrier and Emilio Segrè.

It is estimated that in every kilogram of uranium, there is a mere nanogram of technetium.

So why is it so unstable?

Great question. Unfortunately, this is where science responds with an unsatisfying 'no idea.' Technetium's striking instability remains largely unexplained, despite otherwise flawless models that hold for all the other elements before 83. Although, as always there are theories, involving the parity of the nucleons and energy levels. Nuclear structure is simply far more complex than electronic structure.

Applications

Technetium is one of 27 elements that are superconductors by themselves. It becomes superconducting below -265.69°C, just 7.46°C above absolute zero.

Tc-99m

Nuclear Medicine

A metastable nuclear isomer used as a radioactive tracer. Highly effective due to emitting easily detectable gamma radiation, while having a short but useful half-life of 6 hours. It is the most commonly used medical radioisotope in the world.

$KTcO_4$

Corrosion Protection

An extremely potent anodic corrosion inhibitor for steel, resisting corrosion at 250°C, even fully protecting a specimen of steel for over 20 years in a particular experiment. Only sparingly used in closed systems due to its radioactivity.

^{99}Tc

Instrument Calibration

A National Institute of Standards & Technology standard beta emitter, used for calibrating equipment. Very suited due to only decaying through beta decay, consistently releasing beta particles with low energy and no other gamma rays.

Production

Technetium is produced as a fission product from the radioactive decay of uranium-238 and plutonium-239, both of which are used as fuel in nuclear reactors. It is sourced in bulk from spent nuclear fuel rods, and often stored as molybdenum-99, which technetium can then be extracted from through its decay once it is needed.

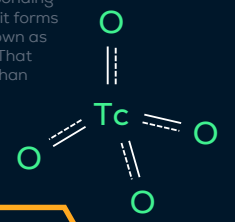
$$^{238}_{92}U \rightarrow {}^{137}_{53}I + {}^{99}_{39}Y + 2\,{}^{1}_{0}n$$

$$^{99}_{39}Y \xrightarrow[1.47s]{} {}^{99}_{40}Zr \xrightarrow[2.1s]{} {}^{99}_{41}Nb \xrightarrow[15.0s]{} {}^{99}_{42}Mb \xrightarrow[65.9h]{} {}^{99}_{43}Tc \xrightarrow[0.211My]{} {}^{99}_{44}Ru$$

The decay chain of uranium to technetium.

Technetium bonds with oxygen to form TcO_4, known as pertechnetate. As well as forming a plethora of interesting compounds, it's also got one of the coolest names in all of Chemistry.

There's more! Bonding with hydrogen, it forms $HTcO_4$, also known as *technetic acid*. That sounds cooler than absolute zero.



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