

# Thorium

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## General Information

### Discovery

Thorium was discovered by J.J. Berzelius in 1815 in Stockholm, Sweden.

### Appearance

Pure thorium is a radioactive silvery-white metal which retains its lustre for several months. When contaminated with the oxide, thorium slowly tarnishes in air, becoming first grey and then black.

### Source

Thorium is found in large deposits in the USA and elsewhere, but these have not been exploited as a source of the element.

Several methods are used to produce the metal, such as reducing thorium oxide with calcium and by the electrolysis of anhydrous thorium chloride.

### Uses

The principal use of thorium is in the Welsbach mantle, which consists of thorium oxide amongst other compounds. This type of mantle glows with a dazzling flame when heated by gas, so is used in portable gas lights. Thorium is also an important alloying agent in magnesium, as it imparts greater strength and creep resistance at high temperatures.

Thorium can be used as a source of nuclear power. It is about three times as abundant as uranium and about as abundant as lead, and there is probably more energy available from thorium than both uranium and fossil fuels. However, although work has been done in developing thorium cycle convertor-reactor systems, it will be many years before such a system is operative - if at all.

### Biological Role

Thorium has no known biological role. It is toxic due to its radioactivity.

## General Information

Pure thorium is soft and very ductile, and has one of the highest melting points of all elements. It is slowly attacked by water and acids. Powdered thorium metal is often pyrophoric. Thorium turnings ignite when heated in air and burn with a brilliant white light.

## Physical Information

Atomic Number	90
Relative Atomic Mass ( $^{12}\text{C}=12.000$ )	232.04
Melting Point/K	2023
Boiling Point/K	5060
Density/kg m <sup>-3</sup>	11720 (293K)
Ground State Electron Configuration	[Rn]6d <sup>2</sup> 7s <sup>2</sup>

## Key Isotopes

Nuclide	<sup>228</sup> Th	<sup>229</sup> Th	<sup>230</sup> Th	<sup>231</sup> Th	<sup>232</sup> Th	<sup>234</sup> Th
Atomic mass	228.03	229.03	230.03	231.03	232.04	234.04
Natural abundance	trace	0%	trace	trace	100%	trace
Half-life	1.9 yrs	7340 yrs	8x10 <sup>4</sup> yrs	25.5 h	1.41x10 <sup>10</sup> yrs	24.1 days

## Ionisation Energies/kJ mol<sup>-1</sup>

M - M <sup>+</sup>	587
M <sup>+</sup> - M <sup>2+</sup>	1110
M <sup>2+</sup> - M <sup>3+</sup>	1978
M <sup>3+</sup> - M <sup>4+</sup>	2780
M <sup>4+</sup> - M <sup>5+</sup>	
M <sup>5+</sup> - M <sup>6+</sup>	
M <sup>6+</sup> - M <sup>7+</sup>	
M <sup>7+</sup> - M <sup>8+</sup>	
M <sup>8+</sup> - M <sup>9+</sup>	
M <sup>9+</sup> - M <sup>10+</sup>	

## Other Information

Enthalpy of Fusion/kJ mol <sup>-1</sup>	19.2
Enthalpy of Vaporisation/kJ mol <sup>-1</sup>	513.7

### Oxidation States

Main	Th <sup>+4</sup>
Others	Th <sup>+2</sup> , Th <sup>+3</sup>