

**\* Name Origin:**

From the Scandinavian god Thor.

**\* Sources:**

Found in various minerals like monazite and thorite.

**\* Uses:**

Used in making strong alloys. Also in ultraviolet photoelectric cells. Bombarded with neutrons make uranium-233, a nuclear fuel.

**\* Additional Notes:**

Discovered by Berzelius in 1828. Thorium occurs in thorite ( $\text{ThSiO}_2$ ) and in thorianite ( $\text{ThO}_2 + \text{UO}_2$ ). Large deposits of thorium minerals have been reported in New England and elsewhere, but these have not yet been exploited. Thorium is now thought to be about three times as abundant as uranium and about as abundant as lead or molybdenum. The metal is a source of nuclear power. There is probably more energy available for use from thorium in the minerals of the earth's crust than from both uranium and fossil fuels. Any sizable demand for thorium as a nuclear fuel is still several years in the future. Work has been done in developing thorium cycle converter-reactor systems. Several prototypes, including the HTGR (hightemperature gas-cooled reactor) and MSRE (molten salt converter reactor experiment), have operated. While the HTGR reactors are efficient, they are not expected to become important commercially for many years because of certain operating difficulties. Thorium is recovered commercially from the mineral monazite, which contains from 3 to 9%  $\text{ThO}_2$  along with rare-earth minerals. Much of the internal heat the earth produces has been attributed to thorium and uranium. Several methods are available for producing thorium metal: it can be obtained by reducing thorium oxide with calcium, by electrolysis of anhydrous thorium chloride in a fused mixture of sodium and potassium chlorides, by calcium reduction of thorium tetrachloride mixed with anhydrous zinc chloride, and by reduction of thorium tetrachloride with an alkali metal. Thorium was originally assigned a position in Group IV of the periodic table. Because of its atomic weight, valence, etc., it is now considered to be the second member of the actinide series of elements. When pure, thorium is a silvery-white metal which is air-stable and retains its luster for several months. When contaminated with the oxide, thorium slowly tarnishes in air, becoming gray and finally black. The physical properties of thorium are greatly influenced by the degree of contamination with the oxide. The purest specimens often contain several tenths of a percent of the oxide. High-purity thorium has been made. Pure thorium is soft, very ductile, and can be cold-rolled, swaged, and drawn. Thorium is dimorphic, changing at  $1400^\circ\text{C}$  from a cubic to a body-centered cubic structure. Thorium oxide has a melting point of  $3300^\circ\text{C}$ , which is the highest of all oxides. Only a few elements, such as tungsten, and a few compounds, such as tantalum carbide, have higher melting points. Thorium is slowly attacked by water, but does not dissolve readily in most common acids, except hydrochloric. Powdered thorium metal is often pyrophoric and should be carefully handled. When heated in air, thorium turnings ignite and burn brilliantly with a white light. The principal use of thorium has been in the preparation of the Welsbach mantle, used for portable gas lights. These mantles, consisting of thorium oxide with

about 1% cerium oxide and other ingredients, glow with a dazzling light when heated in a gas flame. Thorium is an important alloying element in magnesium, imparting high strength and creep resistance at elevated temperatures. Because thorium has a low work-function and high electron emission, it is used to coat tungsten wire used in electronic equipment. The oxide is also used to control the grain size of tungsten used for electric lamps; it is also used for high-temperature laboratory crucibles. Glasses containing thorium oxide have a high refractive index and low dispersion. Consequently, they find application in high quality lenses for cameras and scientific instruments. Thorium oxide has also found use as a catalyst in the conversion of ammonia to nitric acid, in petroleum cracking, and in producing sulfuric acid. Twenty seven isotopes of thorium are known with atomic masses ranging from 212 to 237. All are unstable.  $^{232}\text{Th}$  occurs naturally and has a half-life of  $1.4 \times 10^{10}$  years. It is an alpha emitter.  $^{232}\text{Th}$  goes through six alpha and four beta decay steps before becoming the stable isotope  $^{208}\text{Pb}$ .  $^{232}\text{Th}$  is sufficiently radioactive to expose a photographic plate in a few hours. Thorium disintegrates with the production of "thoron" ( $^{220}\text{Rn}$ ), which is an alpha emitter and presents a radiation hazard. Good ventilation of areas where thorium is stored or handled is therefore essential.