

## SCANDIUM<sup>1</sup>

(Data in kilograms of scandium oxide content unless otherwise noted)

**Domestic Production and Use:** Domestically, scandium-bearing minerals have not been mined nor recovered from mine tailings since 1990, although quantities sufficient to meet demand were available in domestic mine tailings and process residues. Principal sources were imports from China, Russia, and Ukraine. Domestic companies with scandium-processing capabilities were in Mead, CO, and Urbana, IL. Capacity to produce ingot and distilled scandium metal was in Ames, IA; Phoenix, AZ; and Urbana, IL. Scandium used in the United States was derived from foreign sources.

Demand for scandium increased slightly in 2012. The principal use for scandium in 2012 was in aluminum alloys for aerospace components and sporting equipment. Other uses for scandium included analytical standards, electronics, high-intensity metal halide lamps, lasers, metallurgical research, and oil-well tracers.

<b>Salient Statistics—United States:</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012<sup>e</sup></b>
Price, yearend, dollars:					
Per kilogram, oxide, 99.0% purity	900	900	900	900	NA
Per kilogram, oxide, 99.9% purity <sup>2</sup>	1,400	1,400	1,400	3,700	3,700
Per kilogram, oxide, 99.99% purity <sup>2</sup>	1,620	1,620	1,620	4,700	4,700
Per kilogram, oxide, 99.999% purity <sup>2</sup>	2,540	2,540	2,540	5,200	5,200
Per kilogram, oxide, 99.9995% purity <sup>2</sup>	3,260	3,260	3,260	5,900	5,900
Per gram, dendritic, metal <sup>3</sup>	188.00	189.00	193.00	199.00	206.00
Per gram, metal, ingot <sup>4</sup>	152.00	155.00	158.00	163.00	169.00
Per gram, scandium acetate, 99.99% purity <sup>5,6</sup>	NA	NA	47.00	48.40	50.10
Per gram, scandium chloride, 99.9% purity <sup>5</sup>	57.40	60.40	62.40	138.00	143.00
Per gram, scandium fluoride, 99.9% purity <sup>5</sup>	224.20	224.60	229.00	235.80	244.00
Per gram, scandium iodide, 99.999% purity <sup>5</sup>	201.00	203.00	207.00	213.00	220.00
Per kilogram, scandium-aluminum alloy <sup>2</sup>	74.00	74.00	74.00	220.00	220.00
Net import reliance <sup>7</sup> as a percentage of apparent consumption	100	100	100	100	100

**Recycling:** None.

**Import Sources (2008–11):** Although no definitive data exist listing import sources, imported material is thought to be mostly from China.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–12</b>
Mineral substances not elsewhere specified or included, including scandium ores	2530.90.8050	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed, including scandium	2805.30.0000	5.0% ad val.
Mixtures of rare-earth oxides except cerium oxide, including scandium oxide mixtures	2846.90.2010	Free.
Rare-earth compounds, including individual rare-earth oxides, hydroxides, nitrates, and other individual compounds, including scandium oxide	2846.90.8000	3.7% ad val.
Aluminum alloys, other, including scandium-aluminum	7601.20.9090	Free.

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** The supply of domestic and foreign scandium metal remained stable. In New South Wales, Australia, a joint venture continued the development of the the Nyngan deposit; however, at yearend, the project was stalled pending the resolution of a legal dispute between the partners. In northern Queensland, Australia, metallurgical test work was completed in preparation for the development of a scandium-cobalt-nickel deposit. Several projects were underway to improve the technology to recover scandium.

## SCANDIUM

Global scandium consumption was estimated to be less than 10 tons. Scandium-aluminum baseball and softball bats remained popular high-end sports equipment, and sports equipment remained the leading use of scandium; however, scandium producers continued to compete with carbon fiber and carbon nanotube technology for market share. Scandium's use in metal halide lighting continued. Scandium, as the metal or the iodide, was added to halide light bulbs to adjust the color to simulate natural sunlight. New demand is expected to come from future fuel-cell markets and aerospace and specialty metal alloys.

Nominal prices for domestically produced scandium oxide remained unchanged while prices for other scandium compounds increased moderately compared with those of the previous year. Scandium metal prices increased moderately in 2012, and the total market remained very small.

**World Mine Production and Reserves:**<sup>8</sup> No scandium was mined in the United States in 2012. Scandium was produced as byproduct material in China, Kazakhstan, Russia, and Ukraine. Foreign mine production data were not available. Scandium occurs in many ores in trace amounts, but has not been found in sufficient concentration to be mined as a primary product. As a result of its low concentration, scandium has been produced exclusively as a byproduct during processing of various ores or recovered from previously processed tailings or residues.

**World Resources:** Resources of scandium are abundant, especially when considered in relation to demand. Scandium is rarely concentrated in nature because of its lack of affinity for the common ore-forming anions. It is widely dispersed in the lithosphere and forms solid solutions in more than 100 minerals. In the Earth's crust, scandium is primarily a trace constituent of ferromagnesium minerals. Concentrations in these minerals (amphibole-hornblende, biotite, and pyroxene) typically range from 5 to 100 parts per million scandium oxide equivalent. Ferromagnesium minerals commonly occur in mafic and ultramafic igneous rocks. Enrichment of scandium also occurs in aluminum phosphate minerals, beryl, cassiterite, columbite, garnet, muscovite, rare-earth minerals, and wolframite. Scandium that was produced domestically was primarily from the scandium-yttrium silicate mineral thortveitite, and from byproduct leach solutions from uranium operations. One of the principal domestic scandium resources is the fluorite tailings from the mined-out Crystal Mountain deposit near Darby, MT. Tailings from the mined-out fluorite operations, which were generated from 1952 to 1971, contain thortveitite and associated scandium-enriched minerals. Resources also are contained in the tantalum residues previously processed at Muskogee, OK. Smaller resources are associated with molybdenum, titanium-tungsten, and tungsten minerals from the Climax molybdenum deposit in Colorado and in crandallite, kolbeckite, and variscite at Fairfield, UT. Other lower grade domestic resources are present in ores of aluminum, cobalt, iron, molybdenum, nickel, phosphate, tantalum, tin, titanium, tungsten, zinc, and zirconium. Process residues from tungsten operations in the United States also contain significant amounts of scandium.

Foreign scandium resources are known in Australia, China, Kazakhstan, Madagascar, Norway, Russia, and Ukraine. Resources in Australia are contained in nickel and cobalt deposits in Lake Innes and Syerston, New South Wales. China's resources are in iron, tin, and tungsten deposits in Fujian, Guangdong, Guangxi, Jiangxi, and Zhejiang Provinces. Resources in Russia are in apatites and eudialytes in the Kola Peninsula and in uranium-bearing deposits in Kazakhstan. Scandium in Madagascar is contained in pegmatites in the Befanomo area. Resources in Norway are dispersed in the thortveitite-rich pegmatites of the Iveland-Evje Region and in a deposit in the northern area of Finnmark. In Ukraine, scandium is recovered as a byproduct of iron ore processing at Zheltye Voda. An occurrence of the mineral thortveitite is reported from Kobe, Japan. Undiscovered scandium resources are thought to be very large.

**Substitutes:** In applications such as lighting and lasers, scandium is generally not subject to substitution. Titanium and aluminum high-strength alloys, as well as carbon fiber and carbon nanotube material, may substitute in sporting goods, especially baseball and softball bats and bicycle frames. Light-emitting diodes, also known as LEDs, are beginning to displace halides in industrial lighting, residential safety and street lighting, and buoys and maritime lamp applications.

<sup>0</sup>Estimated. NA Not available.

<sup>1</sup>See also Rare Earths.

<sup>2</sup>Scandium oxide (as a white powder) and scandium-aluminum master alloy (with a 2% scandium metal content and sold in metric ton quantities) from Stanford Materials Corp. 2012. The significant price increase in 2011 was based on a price quote received in November 2012.

<sup>3</sup>Scandium pieces, 99.9% purity, distilled dendritic; prices converted from 2-gram prices, from Alfa Aesar, a Johnson Matthey company.

<sup>4</sup>Metal ingot pieces, 99.9% purity, from Alfa Aesar, a Johnson Matthey company.

<sup>5</sup>Acetate, chloride, and fluoride, in crystalline or crystalline aggregate form and scandium iodide as ultradry powder from Alfa Aesar, a Johnson Matthey company; fluoride price converted from 5-gram quantity.

<sup>6</sup>Scandium acetate, 99.9% purity listing beginning in 2010.

<sup>7</sup>Defined as imports – exports + adjustments for industry stock changes.

<sup>8</sup>[See Appendix C for resource/reserve definitions and information concerning data sources.](#)