

## YTTRIUM<sup>1</sup>

[Data in metric tons of yttrium oxide (Y<sub>2</sub>O<sub>3</sub>) content unless otherwise noted]

**Domestic Production and Use:** The rare-earth element yttrium was not mined in the United States in 2010. All yttrium metal and compounds used in the United States were imported. Principal uses were in phosphors for color televisions and computer monitors, temperature sensors, trichromatic fluorescent lights, and x-ray-intensifying screens. Yttria-stabilized zirconia was used in alumina-zirconia abrasives, bearings and seals, high-temperature refractories for continuous-casting nozzles, jet-engine coatings, oxygen sensors in automobile engines, simulant gemstones, and wear-resistant and corrosion-resistant cutting tools. In electronics, yttrium-iron garnets were components in microwave radar to control high-frequency signals. Yttrium was an important component in yttrium-aluminum-garnet laser crystals used in dental and medical surgical procedures, digital communications, distance and temperature sensing, industrial cutting and welding, nonlinear optics, photochemistry, and photoluminescence. Yttrium also was used in heating-element alloys, high-temperature superconductors, and superalloys. The approximate distribution in 2011 by end use was as follows: ceramics, 59%; metallurgy and phosphors (all types), 39%; magnets, metallurgical, electronics, and lasers, 2%.

<b>Salient Statistics—United States:</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011<sup>e</sup></b>
Production, mine	—	—	—	—	—
Imports for consumption:					
In monazite	—	—	—	—	—
Yttrium, alloys, compounds, and metal <sup>e, 2</sup>	676	616	450	670	620
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated <sup>3</sup>	676	616	450	670	620
Price, dollars:					
Monazite concentrate, per metric ton <sup>4</sup>	730	480	480	NA	1,600
Yttrium oxide, per kilogram, 99.9% to 99.99% purity <sup>5</sup>	10–85	10–85	10–85	38–41	75–180
Yttrium metal, per kilogram, 99.99 to 99.999% purity <sup>6</sup>	68–155	68–155	68–155	73–99	160–190
Stocks, processor, yearend	NA	NA	NA	NA	NA
Net import reliance <sup>6, 7</sup> as a percentage of apparent consumption	100	100	100	100	100

**Recycling:** Small quantities, primarily from laser crystals and synthetic garnets.

**Import Sources (2007–10):** Yttrium compounds, greater than 19% to less than 85% weight percent yttrium oxide equivalent: China, 63%; Japan, 9%; France, 6%; United Kingdom, 4%; and other, 18%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12-31-11</b>
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Yttrium-bearing materials and compounds containing by weight >19% to <85% Y <sub>2</sub> O <sub>3</sub>	2846.90.4000	Free.
Other rare-earth compounds, including yttrium oxide ≥85% Y <sub>2</sub> O <sub>3</sub> , yttrium nitrate, and other individual compounds	2846.90.8000	3.7% ad val.

**Depletion Allowance:** Monazite, thorium content, 22% (Domestic), 14% (Foreign); yttrium, rare-earth content, 14% (Domestic and foreign); and xenotime, 14% (Domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** Yttrium consumption in the United States increased in 2010 but was expected to decrease in 2011 based on import data. The United States required yttrium for use in phosphors and in electronics, especially those used in defense applications. Prices for yttrium peaked in a period between July and August. Since that time, the prices have returned to a range of about \$90 to \$130 for oxide and about \$120 to \$160 for metal.

## YTTRIUM

Yttrium production and marketing within China continued to be competitive. China was the source of most of the world's supply of yttrium, from its weathered clay ion-adsorption ore deposits in the southern Provinces, primarily Fujian, Guangdong, and Jiangxi, with a lesser number of deposits in Guangxi and Hunan. Processing was primarily at facilities in Guangdong, Jiangsu, and Jiangxi Provinces. Yttrium was consumed mainly in the form of high-purity oxide compounds for phosphors. Smaller amounts were used in ceramics, electronic devices, lasers, and metallurgical applications.

China was the primary source of most of the yttrium consumed in the United States. About 90% of the imported yttrium compounds, metal, and alloys were sourced from China, with lesser amounts from Japan, France, and Austria.

### World Mine Production and Reserves:

	Mine production <sup>e, 8</sup>		Reserves <sup>9</sup>
	2010	2011	
United States	—	—	120,000
Australia	—	—	100,000
Brazil	15	15	2,200
China	8,800	8,800	220,000
India	55	55	72,000
Malaysia	4	4	13,000
Sri Lanka	—	—	240
Other countries	—	—	17,000
World total (rounded)	8,900	8,900	540,000

**World Resources:** Although reserves may be sufficient to satisfy near-term demand at current rates of production, economics, environmental issues, and permitting and trade restrictions could affect the mining or availability of many of the rare-earth elements, including yttrium. Large resources of yttrium in monazite and xenotime are available worldwide in ancient and recent placer deposits, carbonatites, uranium ores, and weathered clay deposits (ion-adsorption ore). Additional large subeconomic resources of yttrium occur in apatite-magnetite-bearing rocks, deposits of niobium-tantalum minerals, non-placer monazite-bearing deposits, sedimentary phosphate deposits, and uranium ores, especially those of the Blind River District near Elliot Lake, Ontario, Canada, which contain yttrium in brannerite, monazite, and uraninite. Significant yttrium resources are inferred to be in the Bokan Mountain deposit, Prince of Wales Island, Alaska. Additional resources in Canada are contained in allanite, apatite, and britholite at Eden Lake, Manitoba; allanite and apatite at Hoidas Lake, Saskatchewan; and fergusonite and xenotime at Thor Lake, Northwest Territories. Measured yttrium resources have been documented in the Dubbo Zirconia deposit New South Wales, Australia. The world's resources of yttrium are probably very large. Yttrium is associated with most rare-earth deposits. It occurs in various minerals in differing concentrations and occurs in a wide variety of geologic environments, including alkaline granites and intrusives, carbonatites, hydrothermal deposits, laterites, placers, and vein-type deposits.

**Substitutes:** Substitutes for yttrium are available for some applications but generally are much less effective. In most uses, especially in electronics, lasers, and phosphors, yttrium is not subject to substitution by other elements. As a stabilizer in zirconia ceramics, yttria (yttrium oxide) may be substituted with calcia (calcium oxide) or magnesia (magnesium oxide), but they generally impart lower toughness.

<sup>e</sup>Estimated. NA Not available. — Zero.

<sup>1</sup>See also Rare Earths; trade data for yttrium are included in those data shown for rare earths.

<sup>2</sup>Imports based on data from the Port Import/Export Reporting Service (PIERS), Journal of Commerce.

<sup>3</sup>Essentially, all yttrium consumed domestically was imported or refined from imported ores and concentrates.

<sup>4</sup>Monazite price estimated for 2007 through 2010; estimate for 2011 based on sale of concentrate to China from Vietnam in 2009; anonymous marketing source.

<sup>5</sup>Yttrium oxide and metal prices for 5-kilogram to 1-metric-ton quantities from Rhodia Rare Earths, Inc., Shelton, CT; the China Rare Earth Information Center, Baotou, China; Hefa Rare Earth Canada Co., Ltd., Vancouver, Canada; and Stanford Materials Corp., Aliso Viejo, CA.

<sup>6</sup>Purity ranges for metal price quotes changed to 99.99% to 99.999% in 2011 from 99.9% between 2007 and 2010. Vendor list is the same as footnote 5.

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

<sup>8</sup>Includes yttrium contained in rare-earth ores.

<sup>9</sup>See Appendix C for resource/reserve definitions and information concerning data sources.