

## ZIRCONIUM AND HAFNIUM

(Data in metric tons unless otherwise noted)

**Domestic Production and Use:** The zirconium-silicate mineral zircon is produced as a coproduct from the mining and processing of heavy minerals. Typically, both elements are in the ore in a zirconium-to-hafnium ratio of about 50:1. Two firms produced zircon from surface-mining operations in Florida and Virginia. Zirconium metal and hafnium metal were produced from zirconium chemical intermediates by two domestic producers, one in Oregon and the other in Utah. Zirconium chemicals were produced by the metal producer in Oregon and by at least 10 other companies. Ceramics, foundry applications, opacifiers, and refractories are the leading end uses for zircon. Other end uses of zircon include abrasives, chemicals, metal alloys, and welding rod coatings. The leading consumers of zirconium metal and hafnium metal are the nuclear energy and chemical process industries.

<b>Salient Statistics—United States:</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010<sup>e</sup></b>
Production, zircon (ZrO <sub>2</sub> content)	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO <sub>2</sub> content)	23,500	13,000	22,300	9,370	11,600
Zirconium, unwrought, powder, and waste and scrap	256	299	318	451	590
Zirconium, wrought	492	485	715	526	368
Zirconium oxide <sup>1</sup>	2,820	3,740	5,060	2,810	2,370
Hafnium, unwrought, waste and scrap	4	4	12	5	6
Exports:					
Zirconium ores and concentrates (ZrO <sub>2</sub> content)	49,600	43,000	27,400	25,700	34,000
Zirconium, unwrought, powder, and waste and scrap	271	328	591	223	653
Zirconium, wrought	1,610	1,830	2,080	2,080	1,650
Zirconium oxide <sup>1</sup>	3,340	2,400	2,970	3,050	6,110
Consumption, zirconium ores and concentrates, apparent (ZrO <sub>2</sub> content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic <sup>2</sup>	785	763	788	830	850
Imported, f.o.b. <sup>3</sup>	791	872	773	850	860
Zirconium, unwrought, import, France, dollars per kilogram <sup>4</sup>	20	29	41	51	61
Hafnium, unwrought, import, France, dollars per kilogram <sup>4</sup>	209	246	225	421	398
Net import reliance <sup>5</sup> as a percentage of apparent consumption:					
Zirconium	E	E	E	E	E
Hafnium	NA	NA	NA	NA	NA

**Recycling:** In-plant recycled zirconium came from scrap generated during metal production and fabrication and was recycled by companies in Oregon and Utah. Scrap zirconium metal and alloys were recycled by companies in California and Oregon. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Recycling of hafnium metal was insignificant.

**Import Sources (2006–09):** Zirconium mineral concentrates: Australia, 48%; South Africa, 47%; and other, 5%. Zirconium, unwrought, including powder: France, 51%; Germany, 10%; United Kingdom, 10%; South Africa, 9%; and other, 20%. Hafnium, unwrought: France, 60%; Germany, 20%; Canada, 7%; United Kingdom, 6%; and other, 7%.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Normal Trade Relations</b>
			<b>12-31-10</b>
	Zirconium ores and concentrates	2615.10.0000	Free.
	Germanium oxides and zirconium dioxide	2825.60.0000	3.7% ad val.
	Ferrozirconium	7202.99.1000	4.2% ad val.
	Zirconium, unwrought, zirconium powders	8109.20.0000	4.2% ad val.
	Zirconium waste and scrap	8109.30.0000	Free.
	Other zirconium articles	8109.90.0000	3.7% ad val.
	Hafnium, unwrought, hafnium powders	8112.92.2000	Free.

**Depletion Allowance:** 22% (Domestic), 14% (Foreign).

**Government Stockpile:** None.

## ZIRCONIUM AND HAFNIUM

**Events, Trends, and Issues:** Domestic consumption of zirconium mineral concentrates increased significantly compared with that of 2009. Domestic mining of heavy minerals continued near Stony Creek, VA, and Starke, FL.

In 2010, demand for zircon in ceramic, foundry, opacifier, and refractory products increased significantly and was returning to 2007 levels. The number of heavy mineral exploration and mining projects underway declined in recent years. Several projects that had been delayed in 2008 and 2009 owing to lagging consumption resumed. Heavy mineral exploration and mining projects were underway in Australia, Canada, India, Kenya, Madagascar, Mozambique, Russia, Senegal, South Africa, and the United States. Global production of zirconium concentrates (excluding the United States) increased slightly compared with that of 2009. In Australia, heavy mineral mining resumed in the Tiwi Islands, and shipments of a zircon-rutile concentrate began in August. In the Eucla Basin, production at the Jacinth-Ambrosia operation was being ramped up to 300,000 tons per year of zircon concentrate. Meanwhile, in Western Australia, mining operations at Eneabba were idled owing to declining ore grade. In Mozambique, mine production was increasing at the Moma operation to 80,000 tons per year of zircon.

**World Mine Production and Reserves:** World primary hafnium production statistics are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite. The reserves estimates for Australia and other countries have been revised based on new information from Government and company reports. Quantitative estimates of hafnium reserves are not available.

	Zirconium mine production (thousand metric tons)		Zirconium reserves <sup>6</sup> (thousand metric tons, ZrO <sub>2</sub> )
	2009	2010 <sup>e</sup>	
United States	W	W	3,400
Australia	476	481	23,000
Brazil	18	18	2,200
China	130	140	500
India	31	31	3,400
Indonesia	63	60	NA
South Africa	392	390	14,000
Ukraine	35	35	4,000
Other countries	19	30	5,000
World total (rounded)	<sup>7</sup> 1,160	<sup>7</sup> 1,190	56,000

**World Resources:** Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits. Phosphate and sand and gravel deposits have the potential to yield substantial amounts of zircon as a future byproduct. Eudialyte and gittinsite are zirconium silicate minerals that have a potential for zirconia production. Identified world resources of zircon exceed 60 million tons.

Resources of hafnium in the United States are estimated to be about 130,000 tons, available in the 14-million-ton domestic resources of zircon. World resources of hafnium are associated with those of zircon and baddeleyite and exceed 1 million tons.

**Substitutes:** Chromite and olivine can be used instead of zircon for some foundry applications. Dolomite and spinel refractories can also substitute for zircon in certain high-temperature applications. Niobium (columbium), stainless steel, and tantalum provide limited substitution in nuclear applications, while titanium and synthetic materials may substitute in some chemical plant uses.

Silver-cadmium-indium control rods are used in lieu of hafnium at numerous nuclear powerplants. Zirconium can be used interchangeably with hafnium in certain superalloys; in others, only hafnium produces the desired or required grain boundary refinement.

<sup>e</sup>Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Includes germanium oxides and zirconium oxides.

<sup>2</sup>Yearend average price.

<sup>3</sup>Unit value based on U.S. imports for consumption.

<sup>4</sup>Unit value based on U.S. imports for consumption from France.

<sup>5</sup>Defined as imports – exports.

<sup>6</sup>See Appendix C for resource/reserve definitions and information concerning data sources.

<sup>7</sup>Excludes U.S. production.