

## 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. Two firms produced zircon from surface mining operations in Florida, Georgia, and Virginia. Zirconium and hafnium elements were produced from zircon by two domestic producers, one in Oregon and the other in Utah. Typically, both elements are in the ore in a zirconium to hafnium ratio of about 50:1. Primary zirconium chemicals were produced by the Oregon metal producer and at a plant in New Jersey. Secondary zirconium chemicals were produced by 10 other companies. Zirconia ( $ZrO_2$ ) was produced from zircon at plants in Alabama, New Hampshire, New York, Ohio, and by the metal producer in Oregon. Zircon ceramics, opacifiers, refractories, and foundry applications are the leading end uses for zirconium. Other end uses of zirconium include abrasives, chemicals, metal alloys, welding rod coatings, and sandblasting. The leading market for hafnium metal is as an addition in superalloys.

<b>Salient Statistics—United States:</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005<sup>e</sup></b>
Production, zircon ( $ZrO_2$ content)	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates ( $ZrO_2$ content)	39,400	22,900	24,300	22,900	19,400
Zirconium, unwrought, powder, and waste and scrap	145	82	75	89	266
Zirconium, wrought	571	474	468	708	643
Zirconium oxide ( $ZrO_2$ content) <sup>1</sup>	2,950	2,900	2,350	3,960	3,190
Hafnium, unwrought, waste and scrap	5	5	5	4	6
Exports:					
Zirconium ores and concentrates ( $ZrO_2$ content)	43,500	30,600	45,900	44,700	55,600
Zirconium, unwrought, powder, and waste and scrap	186	208	204	233	310
Zirconium, wrought	1,190	1,430	1,490	1,470	1,660
Zirconium oxide ( $ZrO_2$ content) <sup>1</sup>	2,400	1,950	1,520	1,600	2,340
Consumption, zirconium ores and concentrates, apparent ( $ZrO_2$ content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic <sup>2</sup>	340	350	360	557	662
Imported, f.o.b. <sup>3</sup>	356	397	396	477	673
Zirconium, unwrought, dollars per kilogram <sup>4</sup>	31	39	44	31	22
Hafnium, unwrought, dollars per kilogram <sup>4</sup>	138	199	226	269	238
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:** Scrap zirconium metal and alloys was recycled by four companies, one each in California, Michigan, New York, and Texas. In-plant recycled zirconium came from scrap generated during metal production and fabrication and was recycled by companies in Oregon and Utah. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Recycling of hafnium metal was insignificant.

**Import Sources (2001-04):<sup>6</sup>** Zirconium ores and concentrates: Australia, 56%; South Africa, 38%; and other, 6%. Zirconium, unwrought, including powder: Germany, 44%; China, 26%; Canada, 12%; Japan, 11%; and other, 7%. Hafnium, unwrought, including powder: France, 58%; Canada, 27%; China, 7%; Japan, 5%, and other, 3%.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Normal Trade Relations</b>
			<b><u>12-31-05</u></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.

## ZIRCONIUM AND HAFNIUM

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

**Government Stockpile:** None.

**Events, Trends, and Issues:** Global production of zircon increased to 870,000 tons, slightly more than that of 2004, while demand increased 3% compared with that of 2004. Demand for zircon continued to surpass the available supply in 2005. The shortage was caused by increased demand, the closure of several zircon-producing mines, and reduced zircon output because of lower grades at a few foreign mines. Prices for zircon concentrate increased to record-high levels in 2005 in response to the worldwide supply shortfall. In 2005, U.S. imports of zirconium ores and concentrates decreased about 15%, while exports increased 24%. Imports declined as a result of continued high output from recent expansions in Georgia and Virginia and lower domestic demand. A number of new projects to expand the availability of zircon are underway in Australia, Canada, Kenya, Madagascar, Malawi, and Mozambique. Production from a number of these projects was expected to begin in 2006. The availability of hafnium, produced as a byproduct during zirconium metal processing, continued to exceed demand. Russia was the sole producer of baddeleyite in 2005.

**World Mine Production, Reserves, and Reserve Base:** World primary hafnium production statistics are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite.

	Zirconium				Hafnium	
	Mine production (thousand metric tons)		Reserves <sup>7</sup> (million metric tons, ZrO <sub>2</sub> )	Reserve base <sup>7</sup>	Reserves <sup>7</sup> (thousand metric tons, HfO <sub>2</sub> )	Reserve base <sup>7</sup>
	2004	2005 <sup>e</sup>				
United States <sup>1</sup>	W	W	3.4	5.7	68	97
Australia	441	450	9.1	30	180	600
Brazil	26	35	2.2	4.6	44	91
China	17	15	0.5	3.7	NA	NA
India	20	20	3.4	3.8	42	46
South Africa	300	305	14	14	280	290
Ukraine	35	35	4.0	6.0	NA	NA
Other countries	10	10	0.9	4.1	NA	NA
World total (rounded)	850	870	38	72	610	1,100

**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. Eudalyte 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. Columbium (niobium), 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>E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.

<sup>3</sup>U.S. Census Bureau trade data.

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

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

<sup>6</sup>Data for the new trade categories "Zirconium, unwrought, powder" and "Hafnium, unwrought, including powder" are based on 2002-03 only.

<sup>7</sup>See Appendix C for definitions.