

## ZIRCONIUM AND HAFNIUM

(Data in metric tons, unless otherwise noted)

**Domestic Production and Use:** Zircon sand was produced at two mines in Florida and at one mine in Virginia. A new mine was expected to begin operating in Georgia in 2004. Zirconium and hafnium metal were produced from zircon sand by two domestic producers, one in Oregon and the other in Utah. Typically, both metals 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<sub>2</sub>) was produced from zircon sand 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 largest end uses for zirconium. Other end uses of zirconium include abrasives, chemicals, metal alloys, welding rod coatings, and sandblasting. The largest market for hafnium metal is as an addition in superalloys.

<b>Salient Statistics—United States:</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003<sup>e</sup></b>
Production, zircon (ZrO <sub>2</sub> content) <sup>1</sup>	100,000	100,000	100,000	100,000	100,000
Imports:					
Zirconium, ores and concentrates (ZrO <sub>2</sub> content)	37,500	42,400	39,400	22,900	31,100
Zirconium, alloys, waste and scrap, and powder (ZrO <sub>2</sub> content)	1,160	1,400	850	750	677
Zirconium, waste and scrap, other	578	628	772	640	609
Zirconium powder (ZrO <sub>2</sub> content) <sup>2</sup>	3,140	3,950	2,950	2,900	2,210
Hafnium, unwrought, waste and scrap	9	11	5	5	5
Exports:					
Zirconium ores and concentrates (ZrO <sub>2</sub> content)	45,200	47,400	43,500	30,600	44,800
Zirconium, alloys, waste and scrap, and powder (ZrO <sub>2</sub> content)	211	243	251	281	293
Zirconium, waste and scrap, other	1,170	1,410	1,660	1,940	2,000
Zirconium oxide (ZrO <sub>2</sub> content) <sup>2</sup>	1,540	1,680	2,100	2,400	2,160
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>3</sup>	300	340	340	370	360
Imported, f.o.b. <sup>4</sup>	311	396	356	400	370
Zirconium sponge, dollars per kilogram <sup>5</sup>	20-26	20-26	20-31	20-31	20-31
Hafnium sponge, dollars per kilogram <sup>5</sup>	165-209	165-209	119-141	119-141	119-141
Net import reliance <sup>6</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 (1999-2002):** Zirconium ores and concentrates: South Africa, 48%; Australia, 46%; and other, 6%. Zirconium, unwrought, waste and scrap: France, 65%; Germany, 16%; Japan, 6%; Canada, 6%; and other, 7%. Hafnium, unwrought, waste and scrap: France, 70%; Germany, 7%; Canada, 6%; China, 4%; and other, 13%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12/31/03</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.
Zirconium, articles, nesoi	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:** The global supply and demand of zirconium mineral concentrates was nearly balanced in 2003. This situation is expected to continue during the next few years. In the long term, however, supply shortages may occur unless additional production comes online. In 2003, U.S. imports of zirconium ores and concentrates (mostly zircon) increased 36%, while exports were estimated to have increased 46%. A mining operation at Green Cove Springs, FL, was nearing the end of its mine life, and the company shifted to mining the final areas using satellite-mining techniques. A new heavy-mineral sands mine was planned to open in 2004 in southern Georgia. A zircon finishing plant was installed in 2002 at Stony Creek, VA, to improve and upgrade quality and was in full operation in 2003. The availability of hafnium, produced as a byproduct during zirconium metal processing, continued to exceed demand. Baddeleyite production ceased in South Africa in 2001 but production of fused zirconia and zirconium chemicals from zircon concentrate continued. Russia was the sole producer of baddeleyite in 2003.

**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	Reserves <sup>7</sup>	Reserve base <sup>7</sup>	Reserves <sup>7</sup>	Reserve base <sup>7</sup>	
	(thousand metric tons)	(million metric tons, ZrO <sub>2</sub> )		(thousand metric tons, HfO <sub>2</sub> )		
	<u>2002</u>	<u>2003<sup>e</sup></u>				
United States <sup>1</sup>	100	100	3.4	5.3	68	97
Australia	408	400	9.1	30	180	600
Brazil	21	30	2.2	4.6	44	91
China	15	15	0.5	3.7	NA	NA
India	19	20	3.4	3.8	42	46
South Africa	224	280	14	14	280	290
Ukraine	34	34	4.0	6.0	NA	NA
Other countries	<u>9</u>	<u>10</u>	<u>0.9</u>	<u>4.1</u>	<u>NA</u>	<u>NA</u>
World total (rounded)	830	890	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. 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. 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>Rounded to one significant digit to avoid disclosing company proprietary data. ZrO<sub>2</sub> content of zircon is typically 65%.

<sup>2</sup>Includes germanium oxides and zirconium oxides.

<sup>3</sup>E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.

<sup>4</sup>U.S. Census Bureau trade data.

<sup>5</sup>American Metal Market, daily, Miscellaneous prices. Converted from pounds.

<sup>6</sup>Defined as imports – exports.

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