

## 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. 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>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002<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)	58,200	37,500	42,400	39,400	20,900
Zirconium, alloys, waste and scrap, and other (ZrO <sub>2</sub> content)	1,210	1,160	1,400	197	720
Zirconium oxide (ZrO <sub>2</sub> content) <sup>2</sup>	3,900	3,140	3,950	2,950	2,910
Hafnium, unwrought, waste and scrap	12	9	11	5	1
Exports:					
Zirconium ores and concentrates (ZrO <sub>2</sub> content)	26,600	45,200	47,400	43,500	25,300
Zirconium, alloys, waste and scrap, and other (ZrO <sub>2</sub> content)	216	211	259	251	87
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>	320	300	340	340	350
Imported, f.o.b. <sup>4</sup>	355	311	396	356	410
Zirconium sponge, dollars per kilogram <sup>5</sup>	20-26	20-26	20-26	20-31	20-31
Hafnium sponge, dollars per kilogram <sup>5</sup>	165-209	165-209	165-209	119-141	119-141
Net import reliance <sup>6</sup> as a percentage of apparent consumption:					
Zirconium	W	W	W	W	W
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 (1998-2001):** Zirconium ores and concentrates: South Africa, 53%; Australia, 43%; and other, 4%. Zirconium, wrought, unwrought, waste and scrap: France, 63%; Germany, 17%; Japan, 7%; Canada, 5%; and other, 8%. Hafnium, unwrought, waste and scrap: France, 80%; Germany, 8%; United Kingdom, 3%; and other, 9%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12/31/02</b>
Zirconium ores and concentrates	2615.10.0000	Free.
Germanium oxide and zirconium oxide	2825.60.0000	3.7% ad val.
Ferrozirconium	7202.99.1000	4.2% ad val.
Zirconium, other unwrought, powders	8109.20.0000	4.2% ad val.
Zirconium, waste and scrap	8109.30.0000	Free.
Zirconium, other wrought, alloys	8109.90.0000	3.7% ad val.
Unwrought hafnium	8112.92.2000	Free.

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

## ZIRCONIUM AND HAFNIUM

**Government Stockpile:** The National Defense Stockpile (NDS) shipped 16,182 metric tons (17,838 short tons) of zirconium ore (baddeleyite) during fiscal year 2002. The U.S. Department of Energy (DOE) held over 500 tons of zirconium in various forms. DOE also maintained a stockpile of approximately 35 tons of hafnium.

**Events, Trends, and Issues:** The global supply and demand of zirconium mineral concentrates was largely balanced in 2002. This trend is expected to continue over the next few years. In the long-term, however, supply shortages may occur unless new production sources of zirconium concentrates are developed. U.S. imports of zirconium ores and concentrates were estimated to have decreased by 47%, while exports were estimated to have decreased by 58% compared with those of 2001. A mining operation at Green Cove Springs, FL, is nearing the end of its mine life, and dredging at the site will be phased out over the next few years. Smaller economic deposits surrounding the main mined-out ore body will continue to be mined with a mobile mining unit and concentrator. The mining and processing operations at Green Cove Springs will be moved to a new deposit in northern Florida and southern Georgia and are scheduled to commence in 2003. A new zircon finishing plant was installed at Stony Creek, VA, to improve and upgrade product quality. The plant was completed in the fourth quarter of 2002. The availability of hafnium continued to exceed supply. Surpluses were stockpiled in the form of hafnium oxide. The demand for nuclear-grade zirconium metal, the production of which necessitates hafnium's removal, produces more hafnium than can be consumed by its markets.

**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. Reserves and reserve base estimates for Brazil and China have been increased based on new information from those countries.

	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> )	(million metric tons, ZrO <sub>2</sub> )	(thousand metric tons, HfO <sub>2</sub> )	(thousand metric tons, HfO <sub>2</sub> )	
	<u>2001</u>	<u>2002<sup>e</sup></u>				
United States <sup>1</sup>	100	100	3.4	5.3	68	97
Australia	400	400	9.1	30	180	600
Brazil	30	30	2.2	4.6	44	91
China	<sup>e</sup> 15	15	0.5	3.7	NA	NA
India	12	12	3.4	3.8	42	46
South Africa	250	260	14	14	280	290
Ukraine	<sup>e</sup> 75	72	4.0	6.0	NA	NA
Other countries	<u>23</u>	<u>30</u>	<u>0.9</u>	<u>4.1</u>	<u>NA</u>	<u>NA</u>
World total (rounded)	900	910	37	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. 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.