

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 metal were produced from zircon by two domestic producers, one in Oregon and the other in Utah. Typically, both elements occur in the ore in a zirconium-to-hafnium ratio of about 50:1. Primary zirconium chemicals were produced by the metal producer in Oregon and at a plant in New Jersey. Secondary zirconium chemicals were produced by 10 other companies. Zirconia (ZrO₂) was produced from zircon at plants in Alabama, New Hampshire, New York, Ohio, and by the metal producer in Oregon. Ceramics, foundry applications, opacifiers, and refractories are the leading end uses for zircon. Other end uses of zircon include abrasives, chemicals, metal alloys, sandblasting media, and welding rod coatings. The leading consumers of zirconium and hafnium metal are the nuclear energy and chemical process industries.

Salient Statistics—United States:	2002	2003	2004	2005	2006^e
Production, zircon (ZrO ₂ content)	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO ₂ content)	22,900	24,300	22,900	24,800	17,500
Zirconium, unwrought, powder, and waste and scrap	82	75	89	283	249
Zirconium, wrought	474	468	708	741	490
Zirconium oxide [†]	2,900	2,350	3,960	3,160	2,610
Hafnium, unwrought, waste and scrap	5	5	4	4	4
Exports:					
Zirconium ores and concentrates (ZrO ₂ content)	30,600	45,900	44,700	65,600	56,200
Zirconium, unwrought, powder, and waste and scrap	208	204	233	321	249
Zirconium, wrought	1,430	1,490	1,470	1,650	1,650
Zirconium oxide [†]	1,950	1,520	1,600	2,260	3,460
Consumption, zirconium ores and concentrates, apparent (ZrO ₂ content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic ²	350	360	557	570	710
Imported, f.o.b. ³	397	396	477	673	802
Zirconium, unwrought, dollars per kilogram ⁴	39	44	31	22	25
Hafnium, unwrought, dollars per kilogram ⁴	137	195	223	235	187
Net import reliance ⁵ 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 was 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 (2002-05): Zirconium ores and concentrates: Australia, 57%; South Africa, 35%; China, 4%; Canada, 2%; and other, 2%. Zirconium, unwrought, including powder: France, 53%; Germany, 23%; China, 10%; Japan, 7%; and other, 7%. Hafnium, unwrought, including powder: France, 66%; Canada, 22%; China, 6%; Japan, 4%; and other, 2%.

Tariff:	Item	Number	Normal Trade Relations
	Zirconium ores and concentrates	2615.10.0000	<u>12-31-06</u> 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.

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

Government Stockpile: None.

Events, Trends, and Issues: Global production of zirconium concentrates increased to 920,000 tons in 2006, which was a moderate increase compared with that of 2005. Global demand for zircon by the ceramics and chemicals industries helped to increase the demand by 3% compared with that of 2005. Meanwhile, prices for zircon concentrate increased to record-high levels. In 2006, U.S. imports of zirconium ores and concentrates decreased by about 18%, and exports increased by 3%. Cost-cutting measures were expected to idle mining operations in Green Cove Springs, FL, and Lulaton, GA, by yearend. The Green Cove Springs operation has been in production since 1972, and the Lulaton operation was started in 2004. The closures will leave the United States with mining operations in Stony Creek, VA, and Starke, FL. Mine production at the Moma mineral sands project in Mozambique was expected to begin in January 2007. By 2008, Moma's production capacity was expected to reach 800,000 tons per year of ilmenite, 56,000 tons per year of zircon and 21,000 tons per year of rutile. New production from Australia (Douglas, Mindari, Pooncarie, Tiwi Islands), The Gambia (Sanyang), Madagascar (Fort Dauphin), and Malawi (Lake Malawi) are expected to bring the supply of and demand for zirconium concentrates into balance. The availability of hafnium, which is produced as a byproduct during zirconium metal processing, continued to exceed demand.

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. Russia was the sole producer of baddeleyite in 2006; Russian data are included in the "Other countries" category.

	Mine production		Reserves ⁶		Reserve base ⁶	
	Zircon and baddeleyite		(thousand metric tons)		(thousand metric tons)	
	2005	2006 ^e	ZrO ₂ content	HfO ₂ content	ZrO ₂ content	HfO ₂ content
United States	W	W	3,400	68	5,700	97
Australia	445	480	9,100	180	30,000	600
Brazil	35	35	2,200	44	4,600	91
China	17	20	500	NA	3,700	NA
India	20	20	3,400	42	3,800	46
South Africa	305	310	14,000	280	14,000	290
Ukraine	35	37	4,000	NA	6,000	NA
Other countries	20	20	900	NA	4,100	NA
World total (rounded)	880	920	38,000	610	72,000	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), tantalum, and stainless steel provide limited substitution in for zirconium alloys nuclear applications. Titanium alloys and synthetic materials may substitute for zirconium alloys in some chemical plant uses.

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

^eEstimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Includes germanium oxides and zirconium oxides.

²E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.

³U.S. Census Bureau trade data.

⁴Unit value based on U.S. imports for consumption.

⁵Defined as imports – exports.

⁶See Appendix C for definitions.