

ZIRCONIUM AND HAFNIUM

(Data in metric tons unless otherwise noted)

Domestic Production and Use: In 2017, two firms recovered zircon (zirconium silicate) from surface-mining operations in Florida and Georgia as a coproduct from the mining of heavy-mineral sands and the processing of titanium and zirconium mineral concentrates, and a third company began processing existing mineral sands tailings in Florida. Zirconium metal and hafnium metal were produced from zirconium chemical intermediates by one domestic producer in Oregon and one in Utah. Typically, zirconium and hafnium are contained in zircon at a ratio of about 50 to 1. Zirconium chemicals were produced by the metal producer in Oregon and by at least 10 other companies. Ceramics, foundry sand, opacifiers, and refractories are the leading end uses for zircon. Other end uses of zircon include abrasives, chemicals (predominantly, zirconium oxychloride octohydrate and zirconium basic sulfate as intermediate chemicals), metal alloys, and welding rod coatings. The leading consumers of zirconium metal are the chemical process and nuclear energy industries. The leading use of hafnium metal is in superalloys.

Salient Statistics—United States:

	<u>2013</u>	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017^e</u>
Production, zircon (ZrO ₂ content) ¹	W	W	² 50,000	W	² 30,000
Imports:					
Zirconium, ores and concentrates (ZrO ₂ content)	8,050	32,800	20,800	24,900	28,000
Zirconium, unwrought, powder, and waste and scrap	395	843	1,140	1,040	840
Zirconium, wrought	321	257	171	195	240
Hafnium, unwrought, powder, and waste and scrap	10	21	72	180	160
Exports:					
Zirconium ores and concentrates (ZrO ₂ content)	19,000	4,850	3,200	3,280	11,000
Zirconium, unwrought, powder, and waste and scrap	599	534	515	363	550
Zirconium, wrought	1,140	913	1,020	788	630
Consumption, apparent, zirconium ores and concentrates, (ZrO ₂ content) ³	W	W	² 70,000	W	² 50,000
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic ⁴	1,050	1,050	1,025	1,025	1,025
Imported ⁵	996	1,133	1,061	877	881
Zirconium, unwrought, import, France, dollars per kilogram ⁶	75	59	50	46	46
Hafnium, unwrought, import, France, dollars per kilogram ⁶	578	561	607	⁷ NA	⁷ NA
Hafnium, unwrought, dollars per kilogram ⁸	NA	NA	NA	1,088	912
Net import reliance ⁹ as a percentage of apparent consumption:					
Zirconium	E	<50	<25	<50	<50
Hafnium	NA	NA	NA	NA	NA

Recycling: Companies in Oregon and Utah recycled zirconium from new scrap generated during metal production and fabrication and (or) from post-commercial old scrap. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Hafnium metal recycling was insignificant.

Import Sources (2013–16): Zirconium ores and concentrates: South Africa, 59%; Australia, 22%; Senegal, 14%; and other, 5%. Zirconium, unwrought, including powder: China, 67%; Germany, 16%; Japan, 12%; and other, 5%. Hafnium, unwrought: Germany, 46%; France, 32%; United Kingdom, 15%; China, 6%; and other, 1%.

<u>Tariff:</u> Item	<u>Number</u>	<u>Normal Trade Relations</u> <u>12–31–17</u>
Zirconium ores and concentrates	2615.10.0000	Free.
Ferrozirconium	7202.99.1000	4.2% ad val.
Zirconium, unwrought and zirconium powder	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, powder, and waste and scrap	8112.92.2000	Free.

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

Government Stockpile: None.

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Events, Trends, and Issues: Domestic mining and production of zircon concentrates took place at one mine near Starke, FL, and one mine near Nahunta, GA. Production of zircon concentrates increased in 2017 as compared with 2016 owing to a third company which began processing existing mineral sands tailings in Starke, FL. Prices for zircon concentrates were almost unchanged during the year. Apparent consumption was estimated to have increased in 2017, but exports were estimated to have tripled in 2017 because of increased production of zircon concentrates in Florida.

Construction at the Thunderbird Project in Western Australia was expected to begin by yearend 2017. Thunderbird was expected to produce about 50,000 tons per year of zircon concentrate in the first 5 years of operation. In New South Wales, Australia, construction of the Dubbo Zirconia Project (DZP) was also expected to begin in late 2017. The DZP was projected to produce zirconium carbonate (equivalent to 16,300 tons per year of ZrO_2) and more than 200 tons per year of hafnium oxide (HfO_2), as well as niobium, rare-earth, and tantalum products. Production of hafnium metal from HfO_2 at the DZP would be independent of zirconium metal refinement for the nuclear industry where it is a byproduct. Additional heavy-mineral exploration and mining projects were underway in Australia, Mozambique, Sri Lanka, and Tanzania.

World Mine Production and Reserves: World primary hafnium production data are not available. Zirconium reserves for Australia were revised based on data from Geoscience Australia. Reserves for Mozambique were revised based on company reports. Although hafnium occurs with zirconium in the minerals zircon and baddeleyite, quantitative estimates of hafnium reserves are not available.

	Zirconium concentrates, mine production (thousand metric tons, gross weight)		Zirconium reserves ¹⁰ (thousand metric tons, ZrO_2)
	2016	2017 ^e	
United States	W	² 50	500
Australia	450	600	47,000
China	140	140	500
India	40	40	3,400
Indonesia	110	120	NA
Mozambique	68	75	1,800
Senegal	53	60	NA
South Africa	360	400	14,000
Other countries	96	110	7,200
World total (rounded)	¹¹ 1,320	1,600	74,000

World Resources: Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral-sand deposits. Phosphate rock and sand and gravel deposits could potentially yield substantial amounts of zircon as a byproduct. World resources of hafnium are associated with those of zircon and baddeleyite. Quantitative estimates of hafnium resources are not available.

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, and titanium and synthetic materials may substitute in some chemical processing plant applications. 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.

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

¹Contained ZrO_2 content calculated at 65% of gross production.

²Rounded to one significant digit to avoid disclosing company proprietary data.

³Defined as production + imports – exports.

⁴Source: Industrial Minerals, yearend average of high-low price range.

⁵Unit value based on U.S. imports for consumption from Australia, Senegal, and South Africa.

⁶Unit value based on U.S. imports for consumption from France.

⁷Increased imports include unspecified hafnium-containing materials, alloys, and misclassified items.

⁸Source: Argus Media group—Argus Metals International, minimum 99% hafnium, at warehouse (Rotterdam).

⁹Defined as imports – exports.

¹⁰See [Appendix C](#) for resource and reserve definitions and information concerning data sources.

¹¹Excludes U.S. production.