

ZIRCONIUM AND HAFNIUM

(Data in metric tons unless otherwise noted)

Domestic Production and Use: In 2016, two firms recovered zircon (zirconium silicate) from surface-mining operations in Florida and Georgia as a coproduct from the mining and processing of titanium and zirconium mineral concentrates. 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 nuclear energy and chemical process industries. The leading use of hafnium metal is in superalloys.

Salient Statistics—United States:	2012	2013	2014	2015	2016^e
Production, zircon (ZrO ₂ content) ¹	W	W	W	² 50,000	W
Imports:					
Zirconium, ores and concentrates (ZrO ₂ content)	16,700	8,050	32,800	20,700	32,000
Zirconium, unwrought, powder, and waste and scrap	279	395	843	1,140	1,150
Zirconium, wrought	288	321	257	171	250
Hafnium, unwrought, powder, and waste and scrap	24	10	21	72	190
Exports:					
Zirconium ores and concentrates (ZrO ₂ content)	13,000	19,000	5,860	4,080	3,300
Zirconium, unwrought, powder, and waste and scrap	554	600	534	519	360
Zirconium, wrought	1,250	1,140	944	1,020	740
Consumption, zirconium ores and concentrates, apparent (ZrO ₂ content)	W	W	W	² 70,000	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic ³	2,650	1,050	1,050	1,050	1,000
Imported ⁴	2,533	996	1,133	1,061	918
Zirconium, unwrought, import, France, dollars per kilogram ⁵	91	75	59	50	50
Hafnium, unwrought, import, France, dollars per kilogram ⁵	503	578	561	607	⁶ NA
Net import reliance ⁷ as a percentage of apparent consumption:					
Zirconium	<10	E	<50	>25	>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 (2012–15): Zirconium ores and concentrates: South Africa, 70%; Australia, 19%; Senegal, 6%; and other, 5%. Zirconium, unwrought, including powder: China, 65%; Japan, 18%; Germany, 13%; and other, 4%. Hafnium, unwrought: Germany, 40%; France, 29%; United Kingdom, 21%; Australia, 9%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–16
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.

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 decreased significantly because operations ceased at two mines in Virginia where reserves were exhausted during 2015. The operator of the mine near Nahunta, GA, announced a slowdown of production and curtailment of construction at a second mine site in Brantley County owing

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to a continued flat demand for zircon concentrates and a decrease in coproduct titanium mineral sands sales. Prices for zircon concentrates decreased slightly during the year. U.S. net import volumes of zirconium ores and zircon concentrates increased by more than 60% as consumers adjusted to the decrease in the domestic production of zircon. At the end of 2016, the mine in Georgia was returning to full production capacity in anticipation of increased demand.

Several new off-shore projects experienced their first full year of production. In late 2015, production began at the Fairbreeze Mine in South Africa and at the Keysbrook Mine in Western Australia, where production was projected to be 55,000 tons per year and 29,000 tons per year of zircon, respectively.

In New South Wales, Australia, construction of the Dubbo Zirconia Project (DZP) was expected to start in late 2016, and production was expected to begin in 2018. The facility 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. Refinement of HfO_2 into hafnium metal at DZP would be independent of the nuclear industry where it is produced as a byproduct of zirconium metal refinement. Additional heavy-mineral exploration and mining projects were underway in Australia, Madagascar, Mozambique, Sri Lanka, and Tanzania.

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

	Zirconium mineral concentrates, mine production (thousand metric tons, gross weight)		Zirconium reserves ⁸ (thousand metric tons, ZrO_2)
	2015	2016 ⁹	
United States	² 80	W	500
Australia	567	550	48,000
China	140	140	500
India	40	40	3,400
Indonesia	110	110	NA
Mozambique	52	55	920
Senegal	45	50	NA
South Africa	380	400	14,000
Other countries	105	110	7,200
World total (rounded)	1,520	⁹ 1,460	75,000

World Resources: Zirconium resources in the United States included about 14 million tons of zircon 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.

⁹Estimated. 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.

³Source: Industrial Minerals, yearend average of high-low price range.

⁴Unit value based on U.S. imports for consumption from Australia and South Africa.

⁵Unit value based on U.S. imports for consumption from France.

⁶Increased imports include unspecified hafnium-containing materials, alloys, and misclassified items.

⁷Defined as imports – exports.

⁸See [Appendix C](#) for resource and reserve definitions and information concerning data sources.

⁹Excludes U.S. production.