

ZIRCONIUM AND HAFNIUM

(Data in metric tons unless otherwise noted)

Domestic Production and Use: In 2018, 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 processed existing mineral sands tailings in Florida. Zirconium metal and hafnium metal were produced from zirconium chemical intermediates by one producer in Oregon and one in Utah. Zirconium and hafnium are typically contained in zircon at a ratio of about 36 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 basic sulfate and zirconium oxychloride octohydrate 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:	2014	2015	2016	2017	2018^e
Production, zircon, ores and concentrates (ZrO ₂ content) ¹	W	² 50,000	W	² 50,000	² 100,000
Imports:					
Zirconium ores and concentrates (ZrO ₂ content)	32,800	20,800	24,900	24,300	31,000
Zirconium, unwrought, powder, and waste and scrap	843	1,140	1,040	900	2,600
Zirconium, wrought	257	188	195	282	300
Hafnium, unwrought, powder, and waste and scrap	21	72	180	113	36
Exports:					
Zirconium ores and concentrates (ZrO ₂ content)	4,850	3,200	3,280	31,500	80,000
Zirconium, unwrought, powder, and waste and scrap	534	515	363	627	620
Zirconium, wrought	913	1,020	788	972	1,200
Consumption, apparent, zirconium ores and concentrates, (ZrO ₂ content) ³	W	² 70,000	W	² 40,000	² 30,000
Prices:					
Zircon, dollars per metric ton (gross weight):					
Australia, free on board ⁴	1,025	1,025	975	975	NA
China, cost insurance and freight ⁴	NA	NA	NA	1,125	1,500
Imported ⁵	1,133	1,061	877	916	1,200
Zirconium, unwrought, import, China, dollars per kilogram ⁶	55	15	33	12	13
Hafnium, unwrought, dollars per kilogram ⁷	NA	1,250	930	900	775
Net import reliance ⁸ as a percentage of apparent consumption:					
Zircon, ores and concentrates	<50	<25	<50	E	E
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 (2014–17): Zirconium ores and concentrates: South Africa, 55%; Australia, 23%; Senegal, 18%; and other, 4%. Zirconium, unwrought, including powder: China, 70%; Germany, 17%; Japan, 9%; France, 3%; and other, 1%. Hafnium, unwrought: Germany, 47%; France, 30%; United Kingdom, 11%; China, 11%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12–31–18
Zirconium ores and concentrates	2615.10.0000	Free.
Ferrozirconium	7202.99.1000	4.2% ad val.
Zirconium, unwrought and 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 production of zircon concentrates increased sharply in 2018 owing to process improvements and year-round operations of the third company reprocessing mineral sands tailings in Starke, FL. Prices for zircon concentrate imports rose slightly during the year; however, export unit values decreased. Apparent consumption was estimated to have increased in 2018, and exports were estimated to have more than doubled in 2018.

In May 2018, the U.S. Department of the Interior, in coordination with other executive branch agencies, published a list of 35 critical minerals (83 FR 23295), including hafnium and zirconium. This list was developed to serve as an initial focus, pursuant to Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals" (82 FR 60835).

In New South Wales, Australia, construction at the Dubbo Zirconia Project (DZP) at yearend 2018 remained on hold pending financing. 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 (IV) oxide (HfO_2), as well as niobium, rare-earth, and tantalum products. Production of hafnium metal from HfO_2 would be independent of zirconium metal production for the nuclear industry where it is a byproduct.

World Mine Production and Reserves: World primary hafnium production data are not available and quantitative estimates of hafnium reserves are not available. The zirconium reserves estimate for Australia was revised based on data from Geoscience Australia. Reserves for Kenya were revised based on company reporting.

	Zirconium ores and concentrates, mine production (thousand metric tons, gross weight)		Zirconium reserves ⁹ (thousand metric tons, ZrO_2 content)
	2017	2018 ^e	
United States	² 80	² 100	500
Australia	505	500	42,000
China	140	150	500
Indonesia	110	100	NA
Kenya	44	45	3,600
Mozambique	74	80	1,800
Senegal	82	80	NA
South Africa	377	350	14,000
Other countries	<u>138</u>	<u>125</u>	<u>10,600</u>
World total (rounded)	1,550	1,500	73,000

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, average of yearend price. Prices of zircon from Australia were discontinued at yearend 2017.

⁵Unit value based on annual United States imports for consumption from Australia, Senegal, and South Africa.

⁶Unit value based on annual United States imports for consumption from China.

⁷Source: Argus Media group—Argus Metals International, minimum 99% hafnium, at warehouse (Rotterdam), average of yearend price.

⁸Defined as imports – exports.

⁹See Appendix C for resource and reserve definitions and information concerning data sources.