

ZIRCONIUM AND HAFNIUM

(Data in metric tons unless otherwise specified)

Domestic Production and Use: In 2023, one company recovered zircon (zirconium silicate) from surface-mining operations in Florida and Georgia as a coproduct from the mining of heavy-mineral sands, and a second company processed existing mineral sands tailings in California. Abrasive sands, monazite, and titanium mineral concentrates were coproducts of domestic heavy-mineral-sand operations. 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 from domestic and imported materials by the metal producer in Oregon and by at least 10 other companies. Ceramics, foundry sand, opacifiers, and refractories were the leading end uses for zircon, and other end uses included abrasives, 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:

	2019	2020	2021	2022	2023 ^e
Production, zirconium ores and concentrates [zirconium oxide (ZrO ₂) content]	<100,000	<100,000	<100,000	<100,000	<100,000
Imports					
Zirconium ores and concentrates (ZrO ₂ content) ¹	22,600	15,600	18,500	35,400	16,000
Zirconium, unwrought, powder, and waste and scrap	1,820	2,030	746	346	490
Zirconium, wrought	289	302	265	286	310
Hafnium, unwrought, powder, and waste and scrap	32	16	23	43	68
Hafnium, wrought	NA	NA	NA	2	5
Exports:					
Zirconium ores and concentrates (ZrO ₂ content) ^{1, 2}	40,500	12,200	10,000	11,200	14,000
Zirconium, unwrought, powder, and waste and scrap	897	664	589	1,090	1,000
Zirconium, wrought	816	838	966	805	680
Consumption, apparent, ³ zirconium ores and concentrates (ZrO ₂ content) ¹	<100,000	<100,000	<100,000	<100,000	<100,000
Price:					
Zircon, dollars per metric ton (gross weight):					
Premium grade, cost, insurance, and freight, China ⁴	1,620	1,490	1,580	2,170	2,280
Imported ⁵	1,490	1,380	1,440	1,940	2,100
Zirconium, sponge, ex-works China, ⁴ dollars per kilogram	34	25	25	30	28
Hafnium, unwrought, dollars per kilogram	832	778	781	1,590	6,200
Net import reliance ⁶ as a percentage of apparent consumption:					
Zirconium ores and concentrates	E	<25	<25	<50	<25
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 but could not be quantified. Hafnium metal recycling was limited.

Import Sources (2019–22): Zirconium ores and concentrates: South Africa, 46%; Australia, 34%; Senegal, 18%; Russia, 1%; and other, 1%. Zirconium, unwrought, including powder: China, 91%; Germany, 6%; France, 1%; and other, 2%. Zirconium, wrought: France, 66%; Germany, 17%; Belgium, 6%; China, 4%; and other, 7%. Hafnium, unwrought: Germany, 41%; France, 25%; China, 22%; Russia, 5%; and other, 7%.

Tariff:	Item	Number	Normal Trade Relations 12–31–23
	Zirconium ores and concentrates	2615.10.0000	Free.
	Ferrozirconium	7202.99.1000	4.2% ad valorem.
	Zirconium, unwrought and powder	8109.21.0000, 8109.29.0000	4.2% ad valorem.
	Zirconium waste and scrap	8109.31.0000, 8109.39.0000	Free.
	Other zirconium articles	8109.91.0000, 8109.99.0000	3.7% ad valorem.
	Hafnium, unwrought, powder, and waste and scrap	8112.31.0000	Free.
	Hafnium, other	8112.39.0000	4% ad valorem.

Depletion Allowance: 22% (domestic), 14% (foreign).

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Government Stockpile:⁷ The fiscal year (FY) 2024 potential acquisitions include 230 tons of zirconium.

Events, Trends, and Issues: Global mine production of zirconium mineral concentrates increased to about 1.6 million tons in 2023. Advanced exploration and development projects with planned production of zirconium mineral concentrates were ongoing in Australia, Madagascar, Mozambique, Senegal, Tanzania, and elsewhere. U.S. imports of zirconium mineral concentrates decreased significantly in 2023. Australia, Senegal, and South Africa continued to be the leading import sources of zirconium mineral concentrates. The leading global exporters of zirconium mineral concentrates were Australia and South Africa. China was the leading importer of zirconium mineral concentrates. Zircon imports into China included zircon in mixed heavy-mineral concentrates. Global producers of zirconium sponge included China, France, India, Russia, and the United States. The United States was a net exporter of zirconium metal.

Hafnium metal is produced as a byproduct of hafnium-free zirconium metal. Constricted supply combined with increasing demand for hafnium in aerospace alloys and electronics has resulted in an unprecedented increase in hafnium prices.

World Mine Production and Reserves: World primary hafnium production data were not available, and quantitative estimates of hafnium reserves were not available. Zirconium reserves for Australia, China, Mozambique, South Africa, and "Other countries" were revised based on company and Government reports.

	Zirconium mineral concentrates, mine production ^e (thousand metric tons, gross weight)		Zirconium reserves ⁸ (thousand metric tons, ZrO ₂ content) ¹
	2022	2023	
United States	⁹ 100	⁹ 100	500
Australia	500	500	¹⁰ 55,000
China	140	140	72
Indonesia	97	90	NA
Kenya	27	30	18
Madagascar	27	30	2,300
Mozambique	104	90	1,500
Senegal	57	50	2,600
Sierra Leone	34	30	290
South Africa	300	400	5,600
Other countries	57	140	5,700
World total (rounded)	1,440	1,600	74,000

World Resources:⁸ 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 were 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. Boron or cadmium-silver-indium alloys are sometimes used in lieu of hafnium metal in control rods at nuclear powerplants. Zirconium can be used interchangeably with hafnium in certain superalloys.

^eEstimated. E Net exporter. NA Not available.

¹Calculated ZrO₂ content as 65% of gross weight.

²Excludes zircon in mixed mineral concentrates.

³Defined as production + imports – exports.

⁴Source: Argus Media Group, Argus Non-Ferrous Markets, annual average

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

⁶Defined as imports – exports.

⁷See Appendix B for definitions.

⁸See Appendix C for resource and reserve definitions and information concerning data sources.

⁹Data are rounded to the nearest hundred thousand tons to avoid disclosing company proprietary data.

¹⁰For Australia, Joint Ore Reserves Committee-compliant or equivalent reserves were 20 million tons, ZrO₂ content.