

GERMANIUM

(Data in kilograms of contained germanium unless otherwise noted)

Domestic Production and Use: In 2022, zinc concentrates containing germanium were produced at mines in Alaska and Tennessee. Germanium-containing concentrates in Alaska were exported to a refinery in Canada for processing and germanium recovery. A zinc smelter in Clarksville, TN, produced germanium leach concentrates recovered from processing zinc concentrates from the Middle Tennessee Mine. Germanium in the form of compounds and metal was imported into the United States for further processing by industry. A company in Utah produced germanium wafers for solar cells used in satellites from imported and recycled germanium. A refinery in Oklahoma recovered germanium from industry-generated scrap and produced germanium tetrachloride for the production of fiber optics. The estimated value of germanium consumed in 2022, based on the annual average germanium metal price, was \$39 million, 10% more than that in 2021.

<u>Salient Statistics—United States:</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>	<u>2021</u>	<u>2022^e</u>
Production, refinery:					
Primary	—	—	—	—	—
Secondary	W	W	W	W	W
Imports for consumption: ^{e, 1}					
Germanium metal	10,000	14,000	14,000	13,000	14,000
Germanium dioxide	12,000	21,000	12,000	17,000	15,000
Exports, germanium metal and dioxide: ^{e, 1}	3,600	4,500	4,800	7,500	5,800
Shipments from Government stockpile ²	—	—	—	—	—
Consumption, estimated ³	30,000	30,000	30,000	30,000	30,000
Price, annual average, dollars per kilogram: ⁴					
Germanium metal	1,543	1,236	1,046	1,187	1,300
Germanium dioxide	1,084	913	724	770	840
Net import reliance ⁵ as a percentage of estimated consumption	>50	>50	>50	>50	>50

Recycling: During the manufacture of most optical devices, more than 60% of the germanium metal used is routinely recycled as new scrap. Germanium scrap is also recovered from the windows in decommissioned tanks and other military vehicles. The United States has the capability to recycle new and old scrap.

Import Sources (2018–21):^{1, 6} Germanium metal: China, 54%; Belgium, 27%; Germany, 9%; Russia, 8%; and other, 2%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Normal Trade Relations</u>
			<u>12–31–22</u>
	Germanium oxides and zirconium dioxide	2825.60.0000	3.7% ad valorem.
	Metal, unwrought	8112.92.6000	2.6% ad valorem.
	Metal, powder	8112.92.6500	4.4% ad valorem.
	Metal, wrought	8112.99.1000	4.4% ad valorem.

Depletion Allowance: 14% (domestic and foreign).

Government Stockpile:⁷

<u>Material</u>	<u>FY 2022</u>			<u>FY 2023</u>	
	<u>Inventory</u>	<u>Potential</u>	<u>Potential</u>	<u>Potential</u>	<u>Potential</u>
	<u>as of 9–30–22</u>	<u>acquisitions</u>	<u>disposals</u>	<u>acquisitions</u>	<u>disposals</u>
Germanium metal	14,000	—	5,000	—	5,000
Germanium scrap (gross weight)	6,910	—	—	—	—
Germanium wafers (each)	68,700	—	—	—	—

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Events, Trends, and Issues: The major global end uses for germanium were electronics and solar applications, fiber-optic systems, infrared optics, and polymerization catalysts. Other uses included chemotherapy, metallurgy, and phosphors.

The prices for germanium metal and germanium dioxide (Europe, minimum 99.999% purity) increased from January to May and then decreased through late October. The price for germanium metal increased from \$1,380 per kilogram to \$1,470 per kilogram and then decreased to \$1,100 per kilogram. The price for germanium dioxide increased from \$885 per kilogram to \$970 per kilogram and then decreased to \$705 per kilogram.

The Defense Logistics Agency Strategic Materials initiated a program to recycle germanium scrap recovered from decommissioned military equipment. The recycling program was expected to produce up to 3,000 kilograms per year of high-purity germanium ingot that could be consumed for night-vision and thermal-sensing devices and other military uses.

The owner of a zinc smelter in Clarksville, TN, planned to construct a new \$90 million gallium and germanium processing plant at the site, according to local news sources. The plant could potentially recover an estimated 40,000 kilograms per year of germanium.

China was a leading global producer and exporter of germanium in 2022. Exports of unwrought germanium, germanium powders, and germanium waste and scrap (China's export code 8112.99.10) for the year through August were 23,100 kilograms, 7% less than exports in the same period in 2021. More than 90% of exports were sent to Germany, Hong Kong, Japan, Belgium, the United States, and Russia, in descending order of quantity.

World Refinery Production and Reserves:

	Refinery production ^{e, 8}		Reserves ⁹
	<u>2021</u>	<u>2022</u>	
United States	W	W	Data on the recoverable germanium content of zinc ores were not available.
China	NA	NA	
Russia	NA	NA	
Other countries	<u>NA</u>	<u>NA</u>	
World total (rounded)	NA	NA	

World Resources:⁹ The available resources of germanium are associated with certain zinc and lead-zinc-copper sulfide ores. Substantial U.S. reserves of recoverable germanium are contained in zinc deposits in Alaska, Tennessee, and Washington. Based on an analysis of zinc concentrates, U.S. reserves of zinc may contain as much as 2,500 tons of germanium. Because zinc concentrates are shipped globally and blended at smelters, however, the recoverable germanium in zinc reserves cannot be determined. On a global scale, as little as 3% of the germanium contained in zinc concentrates is recovered. Significant amounts of germanium are contained in ash and flue dust generated in the combustion of certain coals for power generation.

Substitutes: Silicon can be a less-expensive substitute for germanium in certain electronic applications. Some metallic compounds can be substituted in high-frequency electronics applications and in some light-emitting-diode applications. Zinc selenide and germanium glass substitute for germanium metal in infrared applications systems, but often at the expense of performance. Antimony and titanium are substitutes for use as polymerization catalysts.

^eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

¹Data have been adjusted to exclude low-value shipments.

²Defined as change in total inventory from prior yearend inventory. If negative, increase in inventory.

³Estimated consumption of germanium contained in metal and germanium dioxide.

⁴Average European price for minimum 99.999% purity. Source: Argus Media group, Argus Metals International.

⁵Defined as imports – exports ± adjustments for Government stock changes.

⁶Import sources are based on gross weight of wrought and unwrought germanium metal and germanium metal powders.

⁷See Appendix B for definitions.

⁸Available information was inadequate to make reliable estimates of world production of germanium.

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