

GERMANIUM

(Data in kilograms of germanium content unless otherwise noted)

Domestic Production and Use: In 2018, zinc concentrates containing germanium were produced at mines in Alaska, Tennessee, and Washington. Germanium-containing concentrates in Alaska and Washington were exported to a refinery in Canada for processing and germanium recovery. A zinc smelter in Clarksville, TN, produced and exported germanium leach concentrates recovered from processing zinc concentrates from the Middle Tennessee Mines. 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 2018, based on the annual average price, was about \$35 million, about 8% more than that in 2017.

Salient Statistics—United States:	2014	2015	2016	2017	2018^e
Production:					
Primary refinery	—	—	—	—	—
Secondary refinery	W	W	W	W	W
Imports for consumption:					
Germanium metal	23,700	20,100	11,000	11,100	8,000
Germanium dioxide ¹	12,500	14,300	15,200	12,000	13,000
Total exports ²	12,000	5,000	4,780	3,670	4,900
Shipments from Government stockpile	³ 3,000	—	—	—	—
Consumption, estimated	32,000	34,000	30,000	30,000	27,000
Price, annual average, dollars per kilogram: ⁴					
Germanium metal	1,918	1,792	1,087	1,082	1,300
Germanium dioxide	1,291	1,211	830	731	1,100
Net import reliance ⁵ as a percentage of estimated consumption	>75%	>75%	>50%	>50%	>50%

Recycling: Worldwide, about 30% of the total germanium consumed is produced from recycled materials. 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 (2014–17):⁶ Germanium metal: China, 58%; Belgium, 26%; Germany, 7%; Russia, 6%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12–31–18
Germanium oxides and zirconium dioxide	2825.60.0000	3.7% ad val.
Metal, unwrought	8112.92.6000	2.6% ad val.
Metal, powder	8112.92.6500	4.4% ad val.
Metal, wrought	8112.99.1000	4.4% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile:⁷

Material	Inventory As of 9–30–18	FY2018		FY 2019	
		Potential Acquisitions	Potential Disposals⁸	Potential Acquisitions	Potential Disposals⁸
Germanium metal	14,004	1,000	—	—	—
Germanium scrap (gross weight)	2,806	—	5,000	—	5,000
Germanium wafers (each)	76,454	—	—	—	—

Events, Trends, and Issues: The major global end uses for germanium were electronics and solar applications, fiber-optic systems, infrared optics, polymerization catalysts, and other uses (such as chemotherapy, metallurgy, and phosphors). Germanium-containing infrared optics were primarily for military use, but the commercial applications for thermal-imaging devices that use germanium lenses have increased during the past few years.

GERMANIUM

Germanium dioxide and germanium metal prices gradually increased from the beginning of 2017 through to January 2018, and then sharply increased from January to March 2018 before stabilizing through to the end of July and decreasing in August. The prices of germanium dioxide and germanium metal increased by 29% and 15%, respectively, during the first 8 months of 2018. Sources attributed the price increases in 2018 to two main events: the partial force majeure at a refinery in Canada, and the implementation of stricter environmental standards in China. The decrease observed in August was attributed to lessened concern for supply availability.

In January 2018, germanium production at a lead-zinc refinery in Canada was disrupted after a breakdown of equipment during an explosion at a slag fuming furnace. The company announced a partial force majeure in January, and in July announced that the furnace would be operational during the fourth quarter of 2018. Germanium production was expected to begin after the furnace was back in operation.

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 germanium. 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 2018, China remained the leading global producer of germanium. China's germanium production growth rate in 2017 and 2018 were affected by the implementation of stricter environmental standards and restrictions. Germanium producers in China continued to integrate with downstream operations in order to sell more value-added germanium products. Germanium's use in fiber optics, infrared, and photovoltaic products increased in China within the last year, which increased demand for the metal.

World Refinery Production and Reserves:⁹

	Refinery production^e		Reserves¹⁰
	<u>2017</u>	<u>2018</u>	
United States	W	W	Data on the recoverable germanium content of zinc ores are not available.
China	60,000	75,000	
Russia	6,000	6,000	
Other countries ¹¹	<u>40,000</u>	<u>35,000</u>	
World total ¹²	106,000	120,000	

World Resources: 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. W Withheld to avoid disclosing company proprietary data. — Zero.

¹Data has been adjusted to exclude low value shipments, then multiplied by 69% to account for germanium content.

²Includes Schedule B numbers: 8112.92.6100, 8112.99.1000, and 2825.60.0000. Data have been adjusted to exclude low-value shipments. Oxide data have been multiplied by 69% to account for germanium content.

³Germanium metal from the National Defense Stockpile that was upgraded to epitaxial wafers.

⁴Average European price for minimum 99.99% 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.

⁸Disposals are defined as any barter, rotation, sale, or upgrade of National Defense Stockpile stock.

⁹Includes both primary and secondary production.

¹⁰See Appendix C for resource and reserve definitions and information concerning data sources.

¹¹Includes Belgium, Canada, Germany, Japan, and Ukraine.

¹²Excludes U.S. production.