

## GERMANIUM

(Data in kilograms, germanium content, unless otherwise specified)

**Domestic Production and Use:** In 2024, zinc concentrates containing germanium were produced at a mine in Alaska. Some of the germanium-containing concentrates produced in Alaska were exported to a refinery in Canada for processing and germanium recovery in the form of dioxide and tetrachloride. Operations at a mine in Tennessee that also produced germanium-containing zinc concentrates remained suspended during the year. Prior to the suspension, the zinc concentrates were sent to a zinc smelter in Clarksville, TN, which recovered the germanium in the form of an intermediate leach concentrate for export. The value of germanium metal and germanium dioxide (gross weight) imported domestically in 2024 was estimated to be \$50 million. A company in St. George, UT, produced germanium wafers mostly for solar cells used in satellites from imported and recycled germanium. A company in Quapaw, OK, produced germanium tetrachloride for the production of fiber optics from imported and recycled germanium materials.

<b>Salient Statistics—United States:</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024<sup>e</sup></b>
Production, refinery:					
Primary	—	—	—	—	—
Secondary	NA	NA	NA	NA	NA
Imports for consumption: <sup>e, 1</sup>					
Germanium metal	14,000	13,000	14,000	22,000	20,000
Germanium dioxide	12,000	17,000	15,000	14,000	13,000
Germanium tetrachloride	NA	NA	NA	NA	NA
Exports: <sup>e, 1</sup>					
Germanium metal	4,000	5,500	6,600	6,000	7,200
Germanium dioxide	810	430	130	110	120
Germanium tetrachloride	NA	NA	NA	NA	NA
Shipments from Government stockpile <sup>2</sup>	—	—	—	NA	NA
Consumption, estimated <sup>3</sup>	30,000	30,000	NA	NA	NA
Price, annual average, dollars per kilogram: <sup>4</sup>					
Germanium metal	1,046	1,187	1,294	1,392	2,100
Germanium dioxide	724	770	828	883	1,400
Net import reliance <sup>5</sup> as a percentage of estimated consumption	>50	>50	>50	>50	>50

**Recycling:** The United States has the capability to recycle new and old germanium scrap. During the manufacture of infrared germanium optics, much of the germanium removed during the machining process is routinely recycled as new scrap. Infrared lenses and windows in decommissioned military equipment also are recycled to recover germanium. Germanium is recycled from certain wastes generated during the manufacture of optical fibers. Germanium wafers used as substrates to produce solar cells also are recycled. Available information was inadequate to make reliable estimates of the amount of secondary germanium produced.

**Import Sources (2020–23):<sup>1</sup>** Germanium metal: China, 51%; Belgium, 27%; Germany, 15%; Russia, 5%; and other, 2%. Germanium dioxide: Belgium, 53%; Canada, 41%; and other, 6%. Combined total: Belgium, 42%; Canada, 23%; China, 23%; Germany, 7%; and other, 5%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–24</b>
Germanium oxides and zirconium dioxide	2825.60.0000	3.7% ad valorem.
Unspecified chlorides, including germanium tetrachloride	2827.39.9000	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:<sup>6</sup>**

<b>Material</b>	<b>FY 2024</b>		<b>FY 2025</b>	
	<b>Potential acquisitions</b>	<b>Potential disposals</b>	<b>Potential acquisitions</b>	<b>Potential disposals</b>
Germanium (gross weight)	—	5,000	—	5,000

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**Events, Trends, and Issues:** The major end uses of germanium in the United States, in descending order, were fiber optics, infrared optics, semiconductor applications and solar cells, and radiation detectors. In the fiber optics industry, germanium dioxide and tetrachloride were consumed during the manufacture of fiber optic glass used for data networking and telecommunication. Germanium metal was processed into lenses for infrared optical systems used in commercial and government markets, fabricated into wafers used as substrates to produce multijunction solar cells used in space applications, and consumed to produce high-purity germanium radiation detectors. Germanium compounds were consumed to produce germane gas used in certain types of semiconductor and solar cell manufacturing. U.S. imports of germanium metal and dioxide (germanium content) were estimated to have increased by about 13% in 2024 from those in 2023 to 33,000 kilograms. More than 94% of total imports of metal and dioxide (germanium content) for the year through August were from Belgium, Germany, Canada, and China in descending order by quantity. In December 2024, China banned all exports of germanium to the United States.

In April, the U.S. Department of Defense awarded a company \$14.4 million to expand and upgrade its germanium wafer manufacturing capabilities at its facility in St. George, UT. The funding was awarded under the Defense Production Act Investment Program and supported the 2024 National Defense Industrial Strategy to increase domestic production and supply chain resilience.

In May, a germanium processor in Belgium and a company in Congo (Kinshasa) entered into a long-term agreement to recover germanium from a mine tailings site in Lubumbashi. The processor in Belgium would assist with the germanium extraction technology at a new recovery plant to be built at the tailings site in exchange for the plant's germanium output. The agreement was facilitated by the Minerals Security Partnership, a collaboration of 14 countries and the European Union to increase investment in responsible critical minerals supply chains.

Global germanium refinery production and recycling data were limited, and available estimates were difficult to verify. China continued to be the leading global producer and exporter of germanium metal in 2024. In August 2023, the Government of China implemented an export licensing program for germanium. China's reported exports of germanium metal for the year through August 2024 decreased by 55% to 16,700 kilograms compared with those in the same period in 2023. These exports were mostly sent to Belgium (33%), Germany (32%), Russia (25%), and Japan (6%). Major germanium producers in China included Yunnan Chihong Germanium and Zinc Co. Ltd. and Yunnan Lincang Xinyuan Germanium Industry Co. Ltd.

Germanium metal and germanium dioxide prices (Europe, minimum 99.999% purity) generally rose between January and September 2024, with the price for germanium metal increasing from \$1,550 per kilogram to \$2,950 per kilogram and the price for germanium dioxide increasing from \$940 per kilogram to \$2,125 per kilogram.

**World Refinery Production and Reserves:**<sup>7</sup> Germanium was known to have been produced or recycled commercially in only a few countries, including the United States, Belgium, Canada, China, Germany, and Russia, with China being the leading producer of germanium. Because most producers do not publicly report germanium production, global production data were limited. Substantial germanium-rich deposits, including tailings sites, that were in operation or in active development were in the United States, China, Congo (Kinshasa), and Russia. However, data were generally not available on the reserves of these deposits.

**World Resources:**<sup>7</sup> Germanium reserves data were not widely reported at a mine or country level and thus difficult to quantify. The available resources of germanium are associated with certain zinc and lead-zinc-copper sulfide ores and lignite coal deposits.

**Substitutes:** Silicon or gallium arsenide 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. Chalcogenide glass has been used as a substitute for germanium metal in infrared applications. Antimony and titanium are substitutes for use as polymerization catalysts.

<sup>6</sup>Estimated. NA Not available. — Zero.

<sup>1</sup>Data have been adjusted to exclude low-value shipments. Germanium dioxide data were multiplied by 69% to calculate the germanium content.

<sup>2</sup>Defined as change in total inventory from prior yearend inventory. If negative, increase in inventory. Beginning in 2023, Government stock changes no longer available.

<sup>3</sup>Estimated consumption of germanium contained in metal and germanium dioxide.

<sup>4</sup>Average European price for minimum 99.999% purity. Source: Argus Media Group, Argus Non-Ferrous Markets.

<sup>5</sup>Defined for 2020–22 as imports – exports ± adjustments for Government stock changes. Beginning in 2023, Government stock changes no longer included.

<sup>6</sup>See Appendix B for definitions.

<sup>7</sup>See Appendix C for resource and reserve definitions and information concerning data sources.