

## GERMANIUM

(Data in kilograms of germanium content unless otherwise noted)

**Domestic Production and Use:** Germanium production in the United States comes from either the refining of imported germanium compounds or domestic industry-generated scrap. Germanium for domestic consumption also was obtained from materials imported in chemical form and either directly consumed or consumed in the production of other germanium compounds. Germanium was recovered from zinc concentrates produced at a domestic zinc mine in Alaska. These concentrates were exported to Canada for processing. A zinc mine complex in Tennessee, which had started producing germanium-rich zinc concentrates in early 2008 and was subsequently closed owing to declining market conditions, resumed operations under new ownership in 2010. There was no indication that any germanium had been recovered from these concentrates in 2011.

A germanium refinery in Utica, NY, produced germanium tetrachloride for optical fiber production. Another refinery in Quapaw, OK, produced refined germanium compounds for the production of fiber optics, infrared devices, and substrates for electronic devices. The major end uses for germanium, worldwide, were estimated to be fiber-optic systems, 30%; infrared optics, 25%; polymerization catalysts, 25%; electronics and solar electric applications, 15%; and other (phosphors, metallurgy, and chemotherapy), 5%. Domestically, the end use distribution was different and was estimated to be infrared optics, 50%; fiber-optic systems, 30%; electronics and solar electric applications, 15%; and other (phosphors, metallurgy, and chemotherapy), 5%. Germanium is not used in polymerization catalysts in the United States. The estimated value of germanium metal consumed in 2010, based upon the annual average U.S. producer price, was about \$38 million.

<b>Salient Statistics—United States:</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011<sup>e</sup></b>
Production, refinery <sup>e</sup>	4,600	4,600	4,600	3,000	3,000
Total imports <sup>1</sup>	52,400	67,600	60,200	44,700	40,000
Total exports <sup>1</sup>	11,700	17,900	21,200	8,000	5,000
Shipments from Government stockpile excesses	6,900	102	68	—	—
Consumption, estimated	60,000	54,000	44,000	40,000	38,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	1,240	1,490	940	1,200	1,650
Dioxide, electronic grade	800	960	580	720	1,400
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, <sup>2</sup> number <sup>e</sup>	65	70	70	100	100
Net import reliance <sup>3</sup> as a percentage of estimated consumption	80	90	90	90	90

**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 was also recovered from the window blanks in decommissioned tanks and other military vehicles.

**Import Sources (2007–10):**<sup>4</sup> China, 41%; Belgium, 29%; Russia, 17%; Germany, 9%; and other, 4%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12-31-11</b>
Germanium oxides	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:** The Defense Logistics Agency, DLA Strategic Materials did not allocate any germanium for sale in the fiscal year 2011 Annual Materials Plan.

### Stockpile Status—9-30-11<sup>5</sup>

<b>Material</b>	<b>Uncommitted inventory</b>	<b>Authorized for disposal</b>	<b>Disposal plan FY 2011</b>	<b>Disposals FY 2011</b>
Germanium	16,362	16,362	—	—

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**Events, Trends, and Issues:** Germanium prices, particularly for germanium dioxide, increased significantly in 2011. During the first 6 months of 2011, free market prices of germanium dioxide increased by 94% to \$1,400 per kilogram from \$720 per kilogram at yearend 2010. During the same period, free market prices of germanium metal increased by a more modest 35% to \$1,625 per kilogram from \$1,200 per kilogram. Factors that contributed to the germanium dioxide price increase included a 2010 export tax on germanium dioxide produced in China that tightened global supply, coupled with the shutdown of a Chinese germanium dioxide plant owing to environmental concerns in early 2011. The Chinese Government was attempting to limit exports of raw materials and encourage the export of more finished products, such as germanium ingots and optical lenses, through export tax rebates on those products. In response to the increased germanium dioxide prices, some domestic germanium consumers found it more economical to purchase germanium in pure metal form instead of as oxide. An early 2011 announcement indicating that China intended to include germanium in a strategic stockpile of rare metals, potentially tightening supply, also contributed to price increases.

According to leading producers of germanium-related products, consumption of germanium substrates, used in light-emitting diodes and solar cells, increased during the first half of 2011 compared with that of the same period of 2010. In 2011, a leading domestic germanium substrate producer began certifying substrates produced at a new manufacturing facility in Oklahoma that was expected to have the capacity to produce about 400,000 substrates per year. The use of germanium substrates in high-efficiency, multijunction solar cells for satellites continued to be a staple of consumption, and more germanium substrates were being used in terrestrial-based solar concentrator systems. In late 2010, a domestic solar cell producer announced that it began mass producing germanium-based multijunction solar cells for terrestrial use that convert concentrated sunlight to electricity at efficiencies as great as 38.5%. Consumption of germanium-based optical blanks for infrared devices (frequently used by the military) declined during the first half of 2011 compared with that in the first half of 2010.

Global consumption of germanium tetrachloride, used primarily in fiber optics, increased during the first half of the year compared with that in the same period of 2010, mainly owing to increased consumption in China. Consumption of germanium dioxide for use in manufacturing plastic bottles was thought to have increased in Japan in the aftermath of the spring 2011 earthquake and tsunami. During the first 6 months of 2011, Japanese germanium dioxide imports increased by about 43% compared with those in the same period of 2010.

### **World Refinery Production and Reserves:**

	Refinery production <sup>e</sup>		Reserves <sup>6</sup>
	2010	2011	
United States	3,000	3,000	450,000
China	80,000	80,000	NA
Russia	5,000	5,000	NA
Other countries	30,000	30,000	NA
World total	118,000	118,000	NA

**World Resources:** The available resources of germanium are associated with certain zinc and lead-zinc-copper sulfide ores. Significant amounts of germanium are contained in ash and flue dust generated in the combustion of certain coals for power generation. Reserves exclude germanium contained in coal ash.

**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. Titanium has the potential to be a substitute as a polymerization catalyst.

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

<sup>1</sup>In addition to the gross weight of wrought and unwrought germanium and waste and scrap that comprise these figures, this series includes estimated germanium content of germanium dioxide. This series does not include germanium tetrachloride and other germanium compounds for which data are not available.

<sup>2</sup>Employment related to primary germanium refining is indirectly related to zinc refining.

<sup>3</sup>Defined as imports – exports + adjustments for Government stock changes; rounded to nearest 5%.

<sup>4</sup>Imports are based on the gross weight of wrought and unwrought germanium and waste and scrap, but not germanium tetrachloride and other germanium compounds for which data are not available.

<sup>5</sup>See Appendix B for definitions.

<sup>6</sup>See Appendix C for resource/reserve definitions and information concerning data sources.