

## GERMANIUM

(Data in kilograms of germanium content, unless otherwise noted)

**Domestic Production and Use:** The value of domestic refinery production of germanium, based upon an estimated 2003 producer price, was \$6 million. Industry-generated scrap, imported concentrates, and processed residues from certain domestic base metal ores were the feed materials for the production of refined germanium in 2003. The domestic industry was based on two zinc mining operations, one in Tennessee and the other in Alaska. The Tennessee operation, which closed in mid-2003, prepared a germanium-rich residue for export to Europe. The Alaskan operation supplied a germanium-bearing concentrate, which was exported to Canada for processing.

A germanium refinery in Utica, NY, produced germanium tetrachloride for optical fiber production. Another refinery in Oklahoma 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 lower in fiber optics than for 2002—polymerization catalysts, 35%; infrared optics, 25%; fiber-optic systems, 20%; electronics/solar electrical applications, 12%; and other (phosphors, metallurgy, and chemotherapy), 8%.

### **Salient Statistics—United States:**

	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003<sup>e</sup></b>
Production, refinery <sup>e</sup>	20,000	23,000	20,000	15,000	12,000
Total imports <sup>1</sup>	12,400	8,220	8,240	13,100	12,000
Exports	NA	NA	NA	NA	NA
Consumption <sup>e</sup>	28,000	28,000	28,000	28,000	24,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	1,400	1,250	890	620	470
Dioxide, electronic grade	900	800	575	400	300
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, <sup>2</sup> number <sup>e</sup>	85	90	90	85	65
Net import reliance <sup>3</sup> as a percentage of estimated consumption	NA	NA	NA	NA	NA

**Recycling:** Worldwide, about 30% of the total germanium consumed is produced from recycled materials. During the manufacture of most electronic and optical devices, more than half of the germanium metal used is routinely recycled as new scrap. Little domestic germanium returns as old scrap because there is a low unit use of germanium in most electronic and infrared devices.

**Import Sources (1999-2002):**<sup>4</sup> China, 33%; Belgium, 25%; Taiwan, 19%; Russia, 9%; and other, 14%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations</b>
		<b>12/31/03</b>
Germanium oxides	2825.60.0000	3.7% ad val.
Waste and scrap	8112.30.3000	Free.
Metal, unwrought	8112.30.6000	2.6% ad val.
Metal, wrought	8112.30.9000	4.4% ad val.

**Depletion Allowance:**<sup>5</sup> 14% (Domestic and foreign).

### **Government Stockpile:**

<b>Material</b>	<b>Stockpile Status—9-30-03<sup>5</sup></b>				
	<b>Uncommitted inventory</b>	<b>Committed inventory</b>	<b>Authorized for disposal</b>	<b>Disposal plan FY 2003</b>	<b>Disposals FY 2003</b>
Germanium	40,263	166	40,263	8,000	1,923

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**Events, Trends, and Issues:** The fiber optic and infrared divisions of the Oklahoma refiner were sold in July 2003, and several mine sources of germanium were scaled-back or closed. Domestic refinery production of germanium was reduced from 2002, and world output was reduced with the closure of a major smelter in France.

Recycling of new scrap continued to grow and remains a significant supply factor. Optical fiber manufacturing was lower owing to a prolonged downturn in the general economy and telecommunications in particular. Higher recycling rates helped to offset increasing polyethylene terephthalate (PET) plastics demand in Asia for germanium dioxide (a catalyst used in the production of PET).

Increases in demand for infrared applications in security, new uses as catalysts, and the potential replacement of gallium arsenide devices by silicon-germanium (SiGe) in wireless telecommunications portend a bright, long-term future for germanium. SiGe chips combine the high-speed properties of germanium with the low-cost, well-established production techniques of the silicon-chip industry. Research on germanium-on-insulator substrates as a replacement for silicon on miniaturized chips continued.

Germanium has little or no effect upon the environment because it usually occurs only as a trace element in ores and carbonaceous materials and is used in very small quantities in commercial applications.

### **World Refinery Production, Reserves, and Reserve Base:**

	Refinery production <sup>e</sup>		Reserves <sup>6</sup>	Reserve base <sup>6</sup>
	2002	2003		
United States	15,000	12,000	400,000	450,000
Other countries	<u>35,000</u>	<u>32,000</u>	NA	NA
World total	50,000	44,000	NA	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. Production of germanium from coal ash is being pursued in Russia and China. Reserves and reserve base figures exclude germanium contained in coal ash.

**Substitutes:** Silicon is less expensive and can be substituted for germanium in certain electronic applications. Although some metallic compounds that contain gallium, indium, selenium, and tellurium can be substituted for germanium, germanium is more reliable than competing materials in many high-frequency and high-power electronics applications and is more economical as a substrate for 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.

New catalysts are being investigated as substitutes for germanium in plastics. Most tend to discolor the plastic, but a new aluminum-base PET catalyst appears to overcome this coloration problem and is less expensive to produce.

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

<sup>1</sup>Gross weight of wrought and unwrought germanium and waste and scrap. Does not include imports of germanium dioxide 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 and industry stock changes.

<sup>4</sup>Imports are based on the gross weight of wrought, unwrought, and waste and scrap. Total imports from republics of the Commonwealth of Independent States (Russia and Ukraine) accounted for 13% of the imports from 1999 to 2002.

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

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