

GERMANIUM

By Errol Sehnke

Germanium is a grayish-white, metallic element with the physical properties of a semiconductor, i.e., it has electrical characteristics between those of a metal and an insulator. It is commercially available as a tetrachloride, a high-purity oxide, and in the form of zone-refined metal ingots, single-crystal bars, castings, doped semiconductors, optical materials, optical blanks, and other specialty products.

Domestic refinery production and consumption for germanium are estimated by the U.S. Geological Survey (USGS) on the basis of discussions with domestic producers. Estimated domestic refinery production of germanium in 1995 remained at approximately the same level as reported for 1994, while U.S. consumption was judged to have increased slightly.

As a strategic and critical material, germanium was included in the National Defense Stockpile (NDS) in 1984, with an initial goal of 30,000 kilograms of germanium metal. In 1987, a new NDS goal of 146,000 kilograms was established; this goal was later adjusted downward in 1991 to 68,198 kilograms. At yearend 1995, the actual inventory was 68,207 kilograms of germanium metal. Additionally, in late 1995, the Defense Logistics Agency (DLA), which maintains the NDS, proposed adding germanium to its materials sales program for fiscal years 1996 and 1997, based largely on legislation pending in the U.S. Congress. Under this proposed plan DLA would, contingent on market conditions, dispose of up to 2,000 kilograms of germanium metal for each of these fiscal years. In a related development, the U.S. House of Representatives/Senate conference on a budget reconciliation bill granted DLA the added authority to sell up to 40,000 kilograms of germanium over the next 7 years (1996-2002).

Production

The USGS estimated domestic refinery production from both primary and secondary materials in 1995 to be 10,000 kilograms, the same as in the prior 2 years.

In 1995, Eagle-Picher Industries Inc.'s Quapaw, OK, Specialty Materials Div. remained the only producer in the United States that recovered primary germanium from zinc smelter residues. Eagle-Picher also reprocessed germanium scrap. Cabot Corp. in Revere, PA, and Atomergic Chemetals Corp., Plainview, NY, produced germanium from reprocessed scrap and semirefined foreign material. The zinc refinery at Clarksville, TN, which Savage Resources Ltd. acquired in 1994, continued to produce germanium-rich residues as a byproduct of processing zinc ores from the new group's associated Elmwood-Gordonville Mine. In addition, the new operating

company, Savage Zinc, Inc., continued the customary practice of shipping these residues to Union Minière's Germanium Business Unit in Belgium for germanium recovery and refining.

Consumption

The USGS estimated domestic consumption of germanium in 1995 at approximately 26,500 kilograms, up somewhat from 1994 levels. The estimated consumption pattern in 1995 was as follows: fiber optics, 40%; infrared-optical systems, 15%; gamma-ray, X-ray, and infrared detectors, 10%; semiconductors (including transistors, diodes, and rectifiers), 5%; and other applications (catalysts, phosphors, metallurgy, and chemotherapy), 30%.

Fiber optics and infrared optical systems continued to be the principal industrial end uses for germanium. In the fiber optics sector, germanium was employed as a dopant within the core of many optical fibers used by the telecommunications industry. In addition, germanium-containing lenses and windows are transparent to infrared radiation, a property that has led to their use in infrared optical systems. These optics are employed principally for military guidance and weapon-sighting applications. Germanium glass also was used for nonmilitary surveillance and monitoring systems in fields such as satellite systems and fire alarms.

Prices

In 1995, domestic producer prices for germanium metal and dioxide were determined to have increased over the long-standing price levels first established in late 1981 (\$1,060 and \$660 per kilogram, respectively). Throughout this 1981 to 1995 period, significant discounting by producers was evident because of competition from imported materials. In 1995, producer prices for zone refined metal reportedly reached \$1,375 per kilogram and germanium dioxide producer prices were at \$880 per kilogram.

Free market prices for germanium dioxide, published by Metal Bulletin (London), started 1995 at \$340 to \$350 per kilogram and ended the year in the \$850 to \$950 per kilogram range.

The price for Belgian-produced germanium dioxide, published by Metal Bulletin (London), started the year at about \$475 per kilogram and rose sharply to approximately \$850 by midyear, the level it maintained until the close of the year.¹

The substantial price increases for germanium materials that occurred in the February to August period were principally

attributed to the depletion of Ukrainian stockpiles and a strong demand for germanium dioxide in Japanese markets.

Foreign Trade

In 1995, the estimated germanium content of imports was approximately 15,400 kilograms, about 10% higher than in 1994. The United Kingdom, Belgium, Russia, China, and Ukraine, in descending order of shipments, accounted for approximately 93% of U.S. germanium imports for 1995. (See table 1.) Imports directly attributable to countries of the former Soviet Union amounted to 3,810 kilograms, about a 43% drop from the 1994 level. Increased shipments from Belgium and the United Kingdom more than compensated for the sharp decline in imports from Estonia and Ukraine.

World Review

World refinery production was estimated at 45,000 kilograms in 1995, a drop of about 1% from 1994 production levels. The total world germanium refinery capacity was judged to have declined slightly in 1995 and was estimated at approximately 265,000 kilograms.

Bulgaria.—It was announced by Bulgaria's Committee for Geology that Aschon Meining AG, a German-Swiss joint venture, was studying the possibility of extracting germanium from tailings and wastes at Bulgaria's thermal powerplants, and from coal deposits at Maritsa Iztok and the Dobroudja and Smolyan areas.²

China.—It was reported in the March 20 issue of China Daily that China had commenced the construction of two major east-west cross country fiber-optic cable lines. It was expected that the two systems would be in operation before yearend. The two long-distance telecommunications lines were funded by the World Bank in an attempt to improve telecommunications within the economically underdeveloped areas of southwest and northwest China. The first of the two lines being constructed will pass from Hangzhou and Fuzhou on China's east coast through Guiyang, Zunyi, and Chongqing to Chengdu in Sichuan Province. Its total length will be 4,352 kilometers, and it will provide 120,000 long distance communications lines. The other system is being built from Beijing through Hohhot and Yinchuan to Lanzhou in Gansu Province, over a distance of 2,133 kilometers, providing 30,000 long-distance communications lines.

In addition, construction reportedly was expected to start in the fourth quarter of 1995 on a 1,580-kilometer-long synchronous digital hierarchy (SDH) fiber optic cable trunk line, running from Wuhan through Hubei Province, Anhui Province, Jiangsu Province, and on to Shanghai. This Wuhan-Shanghai SDH-trunk line was scheduled to be completed and placed into full operation in 1996.

France.—The Direction Generale des Postes et Telecommunications (DGPT) granted MFS Communications S.A. a license to construct and operate an alternative fiber optic network in Paris.³ The first 20-kilometer loop was reportedly

expected to be operational in 1996. MFS plans to construct a fiber ring using SDH to access services including international voice and high-speed data transmission with asynchronous transfer mode (ATM) technology.

Japan.—The market for polyethylene terephthalate (PET) containers continued to grow in Japan, especially in the wake of the high demand created for PET plastic water bottles following the Kobe earthquake disaster.⁴ This strong Japanese demand was attributed by many industry analysts to be one of the principal factors fueling the worldwide rise in germanium dioxide prices because of the chemical's use as a catalyst in the production of PET resins.

Russia.—Supply-side concerns developed in 1995 over Russian germanium dioxide production levels.⁵ Germanium dioxide was customarily sourced from the flue dusts collected at coal burning power stations in Russia. Normally, coal mined in Sakhalin has been shipped to Russian Far East powerplants, with the resulting flue dusts being railed to Krasnoyarsk in western Siberia for the recovery of germanium dioxide. Apparently, this practice was discontinued in 1995 because it had become an unprofitable operation in Russia's newly evolving market-based economic system.

Ukraine.—Germanium production from the Ukrzink plant at Konstantinovka reportedly declined, owing to low levels of germanium contained in the zinc ores processed at the facility in 1995.

Current Research and Technology

The Advanced Research Projects Agency (ARPA) awarded a contract for research work designed to increase the amount of electrically isolated power that can be transported over an optical fiber.⁶ Photonic Power Systems Inc. reportedly was granted \$413,000 by ARPA to develop a system that would deliver 5 watts of electrically isolated power over 5,000 feet of optical fiber. The initial experimental capabilities achieved by the company were 1.7 watts at 12 volts over 300 feet. The ultimate goal of this research is to eventually provide high levels of noise free, electrically isolated power to drive electronic circuitry for signal processing and conditioning uses.

Outlook

In 1995, germanium supplies on a worldwide basis were insufficient to meet the demand for this specialty metal and its related products. Future germanium supplies will remain tight if the increased demand for the fiber optics sector continues as has been projected, and new or expanded sources of supply are not brought on line in the very near future. As might be expected, if sources of supply in the newly independent republics of the former Soviet Union continue to encounter substantial disruption and they are unable to supply market shortfalls, considerable pressure will develop to identify other suppliers to meet the current boost in industrial demand. These alternative sources of supply may include increased releases from the NDS or expansions of current producers in

North America. In fact, if the prevailing supply- demand situation remains in place, prices of processed germanium may be expected to continue at elevated levels or increase to higher levels in the near term. In this environment, competition from alternative materials will become an increasingly significant factor in germanium markets, especially if prices reach and maintain extremely high levels for extended periods of time.

¹Where necessary, values have been converted from Belgian francs (BFr)

to U.S. dollars at the average exchange rate of BFr29.5=US\$1.00.

²Mining Journal. Bulgarian Germanium. V. 324, No. 8314, Feb. 17, 1995, p. 127.

³Photonics Spectra. City of Lights Gets Fiber Net. V. 29, No. 9, Sept. 1995, p. 56.

⁴Metal Bulletin. Germanium Dioxide Prices Continue to Firm. No. 7982, May 25, 1995, p. 7.

⁵Metal Bulletin. Germanium Dioxide Market is Tight. No. 7952, Feb. 6, 1995, p. 8.

⁶Photonics Spectra. Power-via-Fiber Research Gets ARPA Funding. V. 29, No. 12, Dec. 1995, p. 51.

OTHER SOURCES OF INFORMATION

U.S. Geological Survey Publications

Mineral Commodity Summaries, annual.

United States Mineral Resources. U.S. Geol. Surv. Prof. Paper 820, 1973, pp. 237-246.

U.S. Bureau of Mines Publications

Mineral Facts and Problems. U.S. Bur. Mines Bull. 675, 1985, pp. 317- 322.

Other Sources

American Metal Market.

Chemical Abstracts.

Metal Bulletin (London).

Metals Week.

Mining Journal (London).

Roskill's Letter from Japan.

TABLE 1
U.S. IMPORTS OF GERMANIUM MATERIALS 1/, BY COUNTRY 2/

Country	1994		1995	
	Gross weight (kilograms)	Value	Gross weight (kilograms)	Value
Belgium	1,420 r/	\$1,870,000 r/	3,620	\$3,870,000
Canada	22	2,200	--	--
China	2,950	672,000	2,420	1,470,000
Estonia	1,930	362,000	18	11,700
France	305	117,000	25	27,400
Germany	1,900	686,000	171	66,300
Hong Kong	--	--	97	102,000
Israel	273	158,000	182	126,000
Italy	70	11,300	--	--
Japan	--	--	232	135,000
Korea, South	--	--	269	26,200
Lithuania	--	--	185	29,700
Netherlands	139	23,600	--	--
Russia	2,370	439,000	2,960	1,940,000
Switzerland	5	1,750	--	--
Ukraine	2,340	545,000	651	373,000
United Kingdom	1,020	270,000	5,380	2,120,000
Total	14,700	5,160,000 r/	16,200	10,300,000

r/ Revised.

1/ Unwrought and waste and scrap.

2/ Data are rounded by the U.S. Geological Survey to three significant digits; may not add to totals shown.

Source: Bureau of the Census.