In 2016, two domestic zinc operations produced recoverable byproduct germanium. In Alaska, the Red Dog Mine, owned by Teck Resources Ltd. (Canada), produced zinc concentrates that were exported to Teck’s facilities in Canada for processing and to processors in Asia and Europe. Teck Washington Inc. (a wholly owned subsidiary of Teck Resources) operated the underground Pend Oreille zinc and lead mine in northeast Washington State. All concentrates were shipped to Teck’s facilities in Canada for processing. In Tennessee, the Clarksville zinc smelter, owned by Nyrstar NV (Belgium), was thought to have not produced byproduct germanium concentrates because the Middle Tennessee mine complex was put on care-and-maintenance status in December 2015. Operations are not scheduled to resume until 2017 (Nyrstar NV, 2016c). The U.S. Geological Survey (USGS) estimated that in 2016, the combined U.S. refinery production of germanium metal recovered from end-of-life products, such as decommissioned military vehicles and thermal weapons sights, industry-generated scrap, and imported germanium dioxide, was between 5,000 and 15,000 kilograms (kg). The total world production (excluding the United States) of germanium in metal and compounds, including germanium recovered from zinc concentrates, coal fly ash, and recycled material, was estimated to be about 126,000 kg, 14% less than 2015. The amount of germanium recovered from scrap in 2016 was estimated to be about 30% of world production of germanium metal.

Germanium is a hard, brittle semimetal that first was used about 60 years ago as a semiconductor material in radar units and as the material for the first transistors. It is commercially available as tetrachloride, high-purity oxide, and various forms of metal. Its current principal uses include lenses or windows, as substrates required by the National Security Space Strategy photovoltaic solar cell applications. As of yearend 2016, 101,939 wafers were held in the stockpile compared with 101,899 held at yearend 2015 (Defense Logistics Agency Strategic Materials, 2016a, b). In 2015, DLA Strategic Materials entered into a collaborative program with Army Contracting Command–Warren (ACC–Warren) and Anniston Army Depot (ANAD) to recover germanium from excess Army components. Under an ACC–Warren contract, germanium-containing end-of-life components started to be shipped from ANAD to a contractor. The contractor was to demilitarize the components, remove any radioactive coatings from the germanium lenses and windows, and send the germanium scrap to the NDS. In fiscal year 2016, more than 700 kg of clean germanium scrap was shipped to the NDS (U.S. Department of Defense, 2017, p. 6, 8).

Production

Teck Alaska Inc. produced germanium-containing zinc concentrates at its Red Dog zinc-lead open pit mine in Alaska. Approximately 30% of the zinc concentrate produced at Red Dog was sent to Teck’s metallurgical complex in Trail, British Columbia, Canada, for processing. Residues from zinc concentrates were treated in roasters or pressure-leach facilities and purified to produce germanium dioxide, germanium tetrachloride, and other byproduct metals. Teck reported that zinc-in-concentrate production at Red Dog increased by 3% to 583,000 metric tons (t) in 2016 from 567,000 t in 2015 owing to increased mill throughput with softer ores processed. Teck
projected that zinc production at Red Dog would decrease in
the next few years, ranging from 545,000 to 565,000 t in 2017
and from 500,000 to 525,000 metric tons per year (t/yr) in 2018
through 2020 (Teck Resources Ltd., 2017a, p. 36–38, 45).

In December 2014, Teck restarted the Pend Oreille Mine in
Washington State. The mine produced germanium-containing
zinc concentrates that were processed at Teck’s Trail plant.
Zinc-in-concentrate production at Pend Oreille increased to
34,100 t in 2016 from 30,700 t in 2015. Teck projected that
zinc production in 2017 would increase further to between
35,000 and 40,000 t, and there was potential to extend the mine
to at least 2020 (Teck Resources Ltd., 2016, p. 20; 2017a,
p. 39, 45; 2017b).

Nyrstar’s Clarksville zinc smelter in Tennessee was thought
to have not produced byproduct germanium concentrate in 2016
owing to the absence of zinc-concentrate feedstock from the
Middle Tennessee mines. In December 2015, Nyrstar placed
the Middle Tennessee mines on care-and-maintenance status owing
primarily to the decline in the price of zinc during the second
half of 2015. Refined zinc production at the Clarksville smelter in
2016 decreased by 10% from that of 2015 to 111,000 t owing
to the processing of lower grade zinc concentrates following
the suspension of the Middle Tennessee mines. In September 2016,
Nyrstar announced actions for the restart of the mine complex.
 Ore production was projected to commence during the first
quarter of 2017, and mill processing operations were to
commence during the second quarter of 2017 (Nyrstar NV,
2016a, c, 2017).

Secondary germanium metal was recovered by secondary
processors from end-of-life products, such as decommissioned
military vehicles and thermal weapons sights.

Consumption

The USGS estimated that domestic consumption of
germanium metal (including metal content of compounds) was
about 30,000 kg in 2016 (table 1). A major domestic consumer of
germanium reported that demand for germanium tetrachloride
used for infrared optics increased in 2016 from that in 2015
(Umicore s.a., 2017, p. 11, 23–24). Germanium-containing
infrared optics were primarily for military use, and the
commercial and personal markets for thermal-imaging devices
that use germanium lenses has grown over the past few years.
The major global end uses were fiber-optic systems, infrared
optics, electronics and solar applications, polymerization
catalysts, and other uses (such as phosphors, metallurgy,
and chemotherapy).

Fiber-Optic Systems.—Germanium dioxide is used as a dopant
(a substance added in small amounts) in the pure silica glass
core of optical fibers to increase the refractive index, preventing
signal loss while not absorbing light. Three producers in Japan
(Fujikura Ltd.; Furukawa Electric Co., Ltd.; and Sumitomo
Electric Industries, Ltd.) and Corning Inc. in the United States
accounted for a substantial portion of global production of
germanium-doped silica glass used in fiber-optic cable. In
2016, Corning reported that sales of its optical communications
products increased slightly from those in 2015 owing partially to
increased carrier network sales and increased sales of fiber-optic
cable and hardware for fiber-to-the-home installations in North
America (Yi, 2013; Corning Inc., 2017, p. 28).

Infrared Optics.—Germanium was used in lenses and
windows for infrared optical systems owing to its transparency
to part of the infrared spectrum and to its high refractive index.
FLIR Systems, Inc. (Wilsonville, OR), a leading domestic
producer of infrared surveillance devices, reported a 5.9%
increase in sales revenue in 2016 compared with that in
2015. This increase in revenue was primarily a result of its
acquisition of Armastec, Inc. (San Francisco, CA) in June 2016

Polymerization Catalysts.—Estimates indicated that
consumption of germanium for PET outside the United States
has been declining since 2011 owing to germanium price
increases that led to substitutions for germanium. Producers
have substituted lower cost antimony- and titanium-based
products for germanium dioxide catalysts. The majority of
germanium consumed for PET resin production took place in
Japan, where the high brilliancy of the polymer is preferred for
bottle applications.

Solar Cells.—Germanium-based solar cells were used in
space-based applications and terrestrial installations. Umicore
s.a. (Belgium), a leading germanium substrate producer,
reported that orders of substrates for solar cells in space-based
applications decreased in 2016 from that of 2015 (Umicore s.a.,
2017, p. 11, 23–24).

5N Plus Semiconductors LLC (St. George, UT), a wholly
owned subsidiary of 5N Plus Inc. (Canada), primarily produced
germanium substrates for solar cells used in satellites. The
company had the capability to produce germanium metal from
germanium dioxide at its facility in Utah and recover germanium
from industry-generated new scrap at other facilities.

Prices

Germanium is generally traded through long-term supply
contracts among consumers, producers, and traders. Publicly
available prices from Argus Media group – Argus Metals
International are estimates of representative prices in trades
being executed on a particular day and are compiled through
recurring interviews with individual traders. Reported
germanium metal (minimum 99.999% germanium) prices began
the year at about $1,250 per kilogram and decreased during the
year to about $900 per kilogram at yearend. Germanium metal
prices averaged at about $1,087 per kilogram for 2016 (fig. 1,
table 3). Germanium dioxide prices began the year at about
$1,000 per kilogram, trended downward and ended the year at
$625 per kilogram. Germanium dioxide prices averaged at about
$831 per kilogram for 2016 (fig. 1, table 3).

Foreign Trade

According to the U.S. Census Bureau, imports for
consumption of germanium metal (wrought, unwrought, and
powder) decreased by 45% to 11,000 kg in 2016 from 20,100 kg
in 2015 (tables 1, 2). Unwrought germanium metal imports
decreased by 59% to 6,660 kg in 2016 compared with 16,200 kg
in 2015 (table 2). Decreased imports from Belgium, China, and
Germany were partially offset by an increase in imports from Japan. A similar trend was seen in wrought germanium metal; decreased imports from Belgium, China, Germany, and the United Kingdom were partially offset by an increase in imports from Russia. Imports of germanium powder increased to 2,235 kg in 2016 from 899 kg in 2015. In 2016, China, Belgium, and Germany, in descending order of quantity, accounted for 86% of all types of germanium metal imported into the United States. The estimated germanium content of the germanium dioxide imported in 2016 was about 15,200 kg, a 6% increase compared with 14,300 kg in 2015 (table 1).

Domestic exports of germanium metal and articles thereof were estimated to be about 4,780 kg in 2016 based on trade data from the U.S. Census Bureau that were adjusted by the USGS to exclude low-value scrap. Belgium, Germany, Japan, Russia, and the United Kingdom accounted for the majority of germanium exported from the United States in 2016. The estimated germanium content of germanium dioxide exported from the United States in 2016 was less than 100 kg.

**World Review**

In 2016, world production of germanium recovered from zinc concentrates, coal fly ash, and recycled material was estimated to be about 126,000 kg (table 1). Scrap was estimated to have supplied about 30% of the world’s total production of germanium. Owing to the high value of refined germanium, new scrap generated during the manufacture of fiber-optic cables, infrared optics, and substrates was typically reclaimed and fed back into the production process. Recycling of germanium from old scrap, such as fiber-optic windows from decommissioned military vehicles or fiber-optic cables, has increased during the past decade. China accounted for the majority of global germanium production. Primary germanium was recovered from zinc residues in Belgium and Canada (concentrates shipped from the United States), coal ash and zinc residues in China (multiple sources), zinc residues in Finland, and coal ash in Russia.

As a byproduct metal, the supply of germanium was heavily reliant on zinc mine production, which decreased by 7% worldwide in 2016 from that in 2015. Although an important factor, global changes in zinc mine production may not be an indicator of a corresponding change in the supply of germanium. It has been estimated that less than 5% of the germanium contained in zinc concentrates reaches refineries that are capable of extracting and producing germanium (Mikolajczak, 2013, p. 9).

**Australia.**—In 2015, Nyrstar NV announced plans to upgrade production capacity at its zinc smelter in Hobart, Tasmania, Australia. The upgrades included construction of a side-leach plant that would enable the smelter to split base metals from minor metals and produce germanium and indium. The development phase of the project progressed in 2016 and is projected to be completed by yearend 2018 (Nyrstar NV, 2015, 2016b).

**Belgium.**—Umicore produced germanium metal, germanium tetrachloride for fiber optics, germanium substrates, and germanium optical products at its refinery and recycling plant in Olen. In 2016, the company reported decreased sales of substrates for solar cells used in satellites, finished optical devices containing germanium for infrared applications, and germanium tetrachloride for use in fiber optics (Umicore s.a., 2017, p. 11, 23–24).

**Canada.**—The metallurgical complex operated by Teck in Trail, British Columbia, included two specialty metal plants that produced byproduct metals, including germanium. Historically, Teck has been one of the leading germanium producers in the world. The last year for which the company released production data was 2007, when Teck produced about 40,000 kg of germanium dioxide. In 2016, it was estimated that Canada exported about 20,000 kg of germanium contained in dioxide (Teck Cominco Ltd., 2008; Global Trade Information Services Inc., 2017a).

**China.**—China continued to be the leading global producer of germanium metal and germanium compounds, which were recovered from germanium-bearing coal ash and zinc ore. In 2016, an estimated 80,000 kg of germanium metal was produced in China. Germanium prices in China fell steadily throughout 2016. The drop in prices was attributed to an oversupply of germanium and reduced investment demand after the collapse of the Fanya Metal Exchange in 2015 (Metal-Pages, 2016b; Roskill’s Letter from Japan, 2016).

Most of China’s consumption of unwrought germanium in 2016 was used to produce specialized wafer and lens products in order to maximize profits during the decrease in metal prices (Shen, 2016). According to news sources, mines in China reduced their production and sales of germanium concentrates because of low prices. Production was also limited or suspended in some regions of China owing to stricter environmental protection requirements (Minor Metals Monthly, 2017a, p. 29–31). Yunnan Lincang Xinyuan Germanium Industrial Co., Ltd., China’s leading private-sector germanium producer, reported decreasing profits since 2015; in October 2016, the company received a Government subsidy (equivalent to $744,000) to finance the development of value-added germanium products (Metal-Pages, 2016b, c; Shen, 2016).

China exported 16,075 kg of unwrought and wrought germanium metal in 2016, a 48% increase from 10,870 kg in 2015, and imported 3,298 kg of metal in 2016, a 30% decrease compared with that of 2015 (Minor Metals Monthly, 2017b, p. 17–19).

China’s State Reserve Bureau (SRB) was expected to purchase 30,000 kg of germanium for its national stockpile by March 2016 (30,000 kg was purchased in 2015), and analysts expected that China would continue to stockpile germanium during the next several years (Shen, 2015; Metal-Pages, 2016a). The Yunnan local government started bankruptcy proceedings for the Fanya Metal Exchange (FME) in late 2015 and Kunming police have seized FME assets and capital, which included about 70,000 t of nonferrous metals. The FME claimed it held 92 t of germanium in its warehouses before it shut down. It was thought that the germanium stocks previously held by FME could be acquired by China’s SRB stockpiling program (Metal Bulletin, 2016; Roskill’s Letter from Japan, 2016).

**Russia.**—During the past few years, Russia’s germanium production was estimated to have remained stable. Exports in 2016 decreased by about 9% compared to those of 2015 (Global Trade Information Services Inc., 2017b). Germanium and Applications Ltd. recently began recovering germanium...
from fly ash from coal mined at the massive Pavlovskoye coal deposit in the Russian Far East. The company reported that coal production from the open pit mine could yield as much as 21,000 kilograms per year of germanium, and its facilities in Moscow and Novomoskovsk had the capability to produce germanium oxide and metal, germanium blanks for optical use, and substrates for electronics (Germanium and Applications Ltd., 2014).

JSC Germanium operated an integrated refinery in Krasnoyarsk that processed concentrates, fly ash, and waste to produce germanium metal, compounds, and finished products. The company reported that it could produce germanium at a rate of about 20,000 kilograms per year, but it did not specify if that included the metal content of finished products, such as germanium lenses. JSC exported more than 80% of the germanium that it produced (JSC Germanium, 2016).

Outlook

Global demand for fiber-optic cable, led by the emerging Asian economies and Brazil, is likely to increase during the next several years. Germanium-based optical blanks and windows that are incorporated in infrared devices are expected to continue to be heavily used by military and law enforcement agencies. However, increased substitution of specialty glass for pure germanium in infrared applications may continue to be attractive to some consumers. New applications for infrared products that use germanium lenses in commercial and industrial markets are expected to become more prevalent and represent a significant potential for consumption growth. Infrared cameras that are designed to be used with smartphones could become more appealing for commercial uses as prices decline and quality increases. These cameras typically use small quantities of germanium per unit, but the overall volume could be large based on the global proliferation of smartphones.

Germanium production will continue to be reliant on the zinc market. The availability of recycled germanium recovered from end-of-life products, such as fiber optics, military vehicles, and solar cells, is expected to increase during the next two decades as aging products are taken out of service. In China, germanium producers are expected to continue to expand to downstream products and manufacture finished infrared products for export. Overall, the germanium market is expected to remain relatively balanced during the next several years owing to limited sources of supply and modest increases in consumption. This balance could change if some of the germanium stocks held in China begin to enter the global market; however, it is believed that the SRB would continue purchasing germanium through 2017 (Pugsley, 2014).

References Cited


Mikolajczak, Claire, 2013, Germanium market and developments: Utica, NY, Indium Corp. of America, April, presentation, 24 p.


Roskill’s Letter from Japan, 2016, Germany—Prices stabilize as fears over release of FYME stocks are allayed: Roskill’s Letter from Japan, no. 479, July, p. 14–18.


GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Germanium. Ch. in Mineral Commodity Summaries, annual.


Other


### TABLE 1

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<tbody>
<tr>
<td>United States:</td>
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<tr>
<td>Refinery production(^a)</td>
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<tr>
<td>Imports for consumption:</td>
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<td>Germanium metal(^b)</td>
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<td>Germanium dioxide(^c)</td>
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<tr>
<td>Exports, germanium metal(^d)</td>
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<tr>
<td>Consumption, germanium metal(^e)</td>
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<tr>
<td>Price, average:</td>
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<tr>
<td>Germanium metal(^f)</td>
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<td>Germanium dioxide(^g)</td>
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<td>Stocks, December 31, U.S. Government(^h)</td>
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<td>World, refinery production:</td>
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<tr>
<td>China</td>
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<tr>
<td>Russia</td>
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<tr>
<td>Other(^i)</td>
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<td>Total</td>
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</table>

\(^a\)Estimated. \(^b\)Revised. \(^c\)Ditto. \(^d\)Withheld to avoid disclosing company proprietary data; not included in “World, refinery production.”

\(^e\)Includes Harmonized Tariff Schedule of the United States (HTS) codes 8112.92.6000, 8112.92.6500, 8112.99.1000.

\(^f\)Includes HTS code 2825.60.0000. Data have been adjusted to exclude low-value shipments, then multiplied by 69% to account for germanium content.

\(^g\)Includes HTS codes 8112.92.6100, 8112.99.1000, 2825.60.0000. Data have been adjusted to exclude low-value shipments. Oxide data multiplied by 69% to account for germanium content.

\(^h\)Estimated consumption of germanium contained in metal and germanium dioxide.

\(^i\)Minimum 99.99% germanium. Source: Argus Media group – Argus Metals International.

\(^k\)Minimum 99.99% germanium dioxide, approximately 69% metal content. Source: Argus Media group – Argus Metals International.

\(^l\)Defense Logistics Agency Strategic Materials. Data are uncommitted germanium metal only.

\(^m\)Includes Belgium, Canada, Germany, and other countries.

GERMANIUM—2016 [ADVANCE RELEASE] 30.5
## TABLE 2
**U.S. IMPORTS FOR CONSUMPTION OF GERMANIUM METAL, BY COUNTRY OR LOCALITY**

(kilograms and dollars)

<table>
<thead>
<tr>
<th>Country or locality</th>
<th>2012 (quantity)</th>
<th>2012 (value)</th>
<th>2013 (quantity)</th>
<th>2013 (value)</th>
<th>2014 (quantity)</th>
<th>2014 (value)</th>
<th>2015 (quantity)</th>
<th>2015 (value)</th>
<th>2016 (quantity)</th>
<th>2016 (value)</th>
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<tbody>
<tr>
<td><strong>Unwrought:</strong></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Belgium</td>
<td>5,280</td>
<td>8,010,000</td>
<td>2,250</td>
<td>3,720,000</td>
<td>7,010</td>
<td>13,100,000</td>
<td>5,220</td>
<td>8,280,000</td>
<td>1,560</td>
<td>2,070,000</td>
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<td>93,900</td>
<td>2,360</td>
<td>1,020,000</td>
<td>503</td>
<td>62,000</td>
<td>3</td>
<td>8,040</td>
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<tr>
<td>China</td>
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<td>27,600,000</td>
<td>20,800</td>
<td>33,000,000</td>
<td>11,200</td>
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<td>10,700</td>
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<td>Germany</td>
<td>76</td>
<td>136,000</td>
<td>71</td>
<td>143,000</td>
<td>346</td>
<td>515,000</td>
<td>309</td>
<td>427,000</td>
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<td>596,000</td>
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<td>Russia</td>
<td>1,620</td>
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<td>211,000</td>
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<td>151,000</td>
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<td>19,400</td>
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<td>Other (4 countries)</td>
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<td>951,000</td>
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<td>822,000</td>
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<td>441,000</td>
<td>406</td>
<td>661,000</td>
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<td>458,000</td>
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<td>3,430</td>
<td>65</td>
<td>80,700</td>
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<td><strong>Total</strong></td>
<td>1,190</td>
<td>1,670,000</td>
<td>570</td>
<td>978,000</td>
<td>849</td>
<td>1,740,000</td>
<td>899</td>
<td>1,760,000</td>
<td>2,240</td>
<td>2,630,000</td>
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<tr>
<td><strong>Wrought:</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>1,080</td>
<td>971,000</td>
<td>3,250</td>
<td>2,990,000</td>
<td>549</td>
<td>948,000</td>
<td>300</td>
<td>461,000</td>
<td>66</td>
<td>105,000</td>
</tr>
<tr>
<td>Canada</td>
<td>674</td>
<td>936,000</td>
<td>85</td>
<td>117,000</td>
<td>3</td>
<td>36,300</td>
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</tr>
<tr>
<td>China</td>
<td>1,910</td>
<td>2,380,000</td>
<td>2,360</td>
<td>3,920,000</td>
<td>1,910</td>
<td>3,380,000</td>
<td>1,480</td>
<td>2,400,000</td>
<td>684</td>
<td>881,000</td>
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<tr>
<td>Germany</td>
<td>244</td>
<td>403,000</td>
<td>156</td>
<td>471,000</td>
<td>364</td>
<td>802,000</td>
<td>512</td>
<td>1,060,000</td>
<td>226</td>
<td>328,000</td>
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<tr>
<td>Romania</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Russia</td>
<td>1,610</td>
<td>2,400,000</td>
<td>1,650</td>
<td>2,210,000</td>
<td>705</td>
<td>1,110,000</td>
<td>343</td>
<td>500,000</td>
<td>866</td>
<td>1,300,000</td>
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<tr>
<td>United Kingdom</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>4,000</td>
<td>108</td>
<td>33,600</td>
<td>20</td>
<td>35,200</td>
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<tr>
<td>Other (8 countries)</td>
<td>1</td>
<td>6,480</td>
<td>1</td>
<td>18,200</td>
<td>9</td>
<td>42,400</td>
<td>64</td>
<td>109,000</td>
<td>9</td>
<td>10,300</td>
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<tr>
<td><strong>Total</strong></td>
<td>5,510</td>
<td>7,100,000</td>
<td>7,500</td>
<td>9,730,000</td>
<td>3,340</td>
<td>6,330,000</td>
<td>2,960</td>
<td>4,850,000</td>
<td>2,150</td>
<td>3,280,000</td>
</tr>
</tbody>
</table>

-- Zero.

1. Table includes data available through May 23, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

2. Includes Harmonized Tariff Schedule of the United States (HTS) code 8112.92.6000.

3. Includes HTS code 8112.92.6500.

4. Includes HTS code 8112.99.1000.

Source: U.S. Census Bureau.

## TABLE 3
**ANNUAL AVERAGE PRICES**

(Dollars per kilogram)

<table>
<thead>
<tr>
<th></th>
<th>Germanium metal (minimum 99.99% purity)</th>
<th>Germanium dioxide (minimum 99.99% purity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>1,106</td>
<td>767</td>
</tr>
<tr>
<td>2008</td>
<td>1,456</td>
<td>948</td>
</tr>
<tr>
<td>2009</td>
<td>1,054</td>
<td>677</td>
</tr>
<tr>
<td>2010</td>
<td>953</td>
<td>575</td>
</tr>
<tr>
<td>2011</td>
<td>1,539</td>
<td>1,218</td>
</tr>
<tr>
<td>2012</td>
<td>1,464</td>
<td>1,179</td>
</tr>
<tr>
<td>2013</td>
<td>1,778</td>
<td>1,307</td>
</tr>
<tr>
<td>2014</td>
<td>1,918</td>
<td>1,291</td>
</tr>
<tr>
<td>2015</td>
<td>1,792</td>
<td>1,211</td>
</tr>
<tr>
<td>2016</td>
<td>1,087</td>
<td>831</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>1,415</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Source: Argus Media group – Argus Metals International.
Figure 1. Average annual prices for germanium metal and germanium dioxide from 2006 through 2016. Source: Argus Media group – Argus Metals International.