

## GERMANIUM

(Data in kilograms of contained germanium unless otherwise noted)

**Domestic Production and Use:** In 2021, zinc concentrates containing germanium were produced at mines in Alaska and Tennessee. Germanium-containing concentrates in Alaska were exported to a refinery in Canada for processing and germanium recovery. A zinc smelter in Clarksville, TN, produced and exported germanium leach concentrates recovered from processing zinc concentrates from the Middle Tennessee mine complex. Germanium in the form of compounds and metal was imported into the United States for further processing by industry. A company in Utah produced germanium wafers for solar cells used in satellites from imported and recycled germanium. A refinery in Oklahoma recovered germanium from industry-generated scrap and produced germanium tetrachloride for the production of fiber optics. The estimated value of germanium consumed in 2021, based on the annual average germanium metal price, was \$36 million, 15% more than that in 2020.

| <b><u>Salient Statistics—United States:</u></b>                           | <b><u>2017</u></b> | <b><u>2018</u></b> | <b><u>2019</u></b> | <b><u>2020</u></b> | <b><u>2021<sup>e</sup></u></b> |
|---|--------------------|--------------------|--------------------|--------------------|--------------------------------|
| Production, refinery:   |                    |                    |                    |                    |                                |
| Primary   | —                  | —                  | —                  | —                  | —                              |
| Secondary   | W                  | W                  | W                  | W                  | W                              |
| Imports for consumption:  |                    |                    |                    |                    |                                |
| Germanium metal   | 11,100             | 11,900             | 14,000             | 18,300             | 13,000                         |
| Germanium dioxide <sup>e, 1</sup>   | 12,000             | 12,200             | 21,000             | 12,000             | 17,000                         |
| Exports <sup>e, 2</sup>   | 3,670              | 4,880              | 4,600              | 7,100              | 6,600                          |
| Shipments from Government stockpile                                       | —                  | —                  | —                  | —                  | —                              |
| Consumption, estimated <sup>3</sup>                                       | 30,000             | 30,000             | 30,000             | 30,000             | 30,000                         |
| Price, annual average, dollars per kilogram: <sup>4</sup>                 |                    |                    |                    |                    |                                |
| Germanium metal   | 1,082              | 1,543              | 1,236              | 1,046              | 1,200                          |
| Germanium dioxide   | 731                | 1,084              | 913                | 724                | 770                            |
| Net import reliance <sup>5</sup> as a percentage of estimated consumption | >50%               | >50%               | >50%               | >50%               | >50%                           |

**Recycling:** Worldwide, it has been estimated that 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 is also recovered from the windows in decommissioned tanks and other military vehicles. The United States has the capability to recycle new and old scrap.

**Import Sources (2017–20):**<sup>6</sup> Germanium metal: China, 53%; Belgium, 22%; Germany, 11%; Russia, 9%; and other, 5%.

| <b><u>Tariff:</u></b> | <b><u>Item</u></b>                     | <b><u>Number</u></b> | <b><u>Normal Trade Relations</u></b> |
|-----------------------|--|----------------------|--------------------------------------|
|                       |  |                      | <b><u>12–31–21</u></b>               |
|                       | Germanium oxides and zirconium dioxide | 2825.60.0000         | 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>7</sup>

| <b><u>Material</u></b>         | <b><u>Inventory</u></b> | <b><u>FY 2021</u></b>       |                         | <b><u>FY 2022</u></b>      |                         |
|--------------------------------|-------------------------|-----------------------------|-------------------------|----------------------------|-------------------------|
|                                |                         | <b><u>as of 9–30–21</u></b> | <b><u>Potential</u></b> | <b><u>Potential</u></b>    | <b><u>Potential</u></b> |
|                                |                         | <b><u>acquisitions</u></b>  | <b><u>disposals</u></b> | <b><u>acquisitions</u></b> | <b><u>disposals</u></b> |
| Germanium metal                | 14,000                  | —                           | —                       | —                          | 5,000                   |
| Germanium scrap (gross weight) | 6,170                   | —                           | 3,000                   | —                          | —                       |
| Germanium wafers (each)        | 68,700                  | —                           | —                       | —                          | —                       |

## GERMANIUM

**Events, Trends, and Issues:** The major global end uses for germanium were electronics and solar applications, fiber-optic systems, infrared optics, polymerization catalysts, and other uses (such as chemotherapy, metallurgy, and phosphors).

Prices for germanium dioxide and metal trended upward during 2021. During the first 10 months of the year, the price for germanium metal (minimum 99.999% purity) increased by 21% to \$1,315 per kilogram from \$1,090 per kilogram, and the price for germanium dioxide (minimum 99.999% purity) increased by 15% to \$825 per kilogram from \$720 per kilogram.

In 2021, a high-purity metals and compounds producer with a germanium wafer production facility in Utah acquired a Germany-based manufacturer of multijunction germanium solar cells for space and terrestrial applications. An advanced materials producer with a germanium production facility in Oklahoma announced that a new generation of solar arrays using germanium substrates were produced for the International Space Station to replace the existing silicon-based solar arrays. Similar germanium solar cell technology would also be used to power the National Aeronautics and Space Administration's Gateway space station currently under development.

China was a leading global exporter of germanium in 2021. Exports of unwrought germanium, germanium powders, and germanium waste and scrap (China's export code 8112.99.10) for the year through September were 27,800 kilograms, 24% more than exports in the same period in 2020. Nearly all exports were sent to Russia, Germany, Hong Kong, Belgium, Japan, and the United States, in descending order of quantity.

### World Refinery Production and Reserves:

|                                     | Refinery production <sup>e, 8</sup> |         | Reserves <sup>9</sup>   |
|-------------------------------------|-------------------------------------|---------|---|
|                                     | 2020                                | 2021    |   |
| United States                       | W                                   | W       | Data on the recoverable germanium content of zinc ores are not available. |
| China                               | 95,000                              | 95,000  |   |
| Russia                              | 5,000                               | 5,000   |   |
| Other countries <sup>10</sup>       | 40,000                              | 40,000  |   |
| World total (rounded) <sup>11</sup> | 140,000                             | 140,000 |   |

**World Resources:**<sup>9</sup> The available resources of germanium are associated with certain zinc and lead-zinc-copper sulfide ores. Substantial U.S. reserves of recoverable germanium are contained in zinc deposits in Alaska, Tennessee, and Washington. Based on an analysis of zinc concentrates, U.S. reserves of zinc may contain as much as 2,500 tons of germanium. Because zinc concentrates are shipped globally and blended at smelters, however, the recoverable germanium in zinc reserves cannot be determined. On a global scale, as little as 3% of the germanium contained in zinc concentrates is recovered. Significant amounts of germanium are contained in ash and flue dust generated in the combustion of certain coals for power generation.

**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. Antimony and titanium are substitutes for use as polymerization catalysts.

<sup>e</sup>Estimated. W Withheld to avoid disclosing company proprietary data. — Zero.

<sup>1</sup>Data have been adjusted to exclude low-value shipments, then multiplied by 69% to account for germanium content.

<sup>2</sup>Includes Schedule B numbers: 8112.92.6100, 8112.99.1000, and 2825.60.0000. Data have been adjusted to exclude low-value shipments. Oxide data have been multiplied by 69% to account for germanium content.

<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 Metals International.

<sup>5</sup>Defined as imports – exports + adjustments for Government stock changes.

<sup>6</sup>Import sources are based on gross weight of wrought and unwrought germanium metal and germanium metal powders.

<sup>7</sup>See Appendix B for definitions.

<sup>8</sup>Includes primary and secondary production.

<sup>9</sup>See Appendix C for resource and reserve definitions and information concerning data sources.

<sup>10</sup>Includes Belgium, Canada, Germany, Japan, and Ukraine.

<sup>11</sup>Excludes U.S. production.