

## GALLIUM

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

**Domestic Production and Use:** No domestic primary gallium recovery was reported in 1996. Two companies in Oklahoma and Utah recovered and refined gallium from scrap and impure gallium metal. Imports of gallium, which supplied most of U.S. gallium consumption, were valued at about \$7.9 million. Gallium arsenide (GaAs) components represented about 95% of domestic gallium consumption. About 88% of the gallium consumed was used in optoelectronic devices, which include light-emitting diodes (LED's), laser diodes, photodetectors, and solar cells. Integrated circuits represented 12% of gallium demand. The remainder (less than 1%) was used in research and development, specialty alloys, and other applications. Optoelectronic devices were used in areas such as consumer goods, medical equipment, industrial components, telecommunications, and aerospace applications. Integrated circuits were used in defense applications and high-performance computers.

<b>Salient Statistics—United States:</b>	<b>1992</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996<sup>e</sup></b>
Production, primary <sup>e</sup>	—	—	—	—	—
Imports for consumption	8,480	15,600	16,900	18,100	25,000
Exports	NA	NA	NA	NA	NA
Consumption: Reported	10,600	11,300	15,500	16,900	21,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure	425	400	395	425	425
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery <sup>e</sup> , number	20	20	20	20	20
Net import reliance <sup>1</sup> as a percent of apparent consumption	NA	NA	NA	NA	NA

**Recycling:** Old scrap, none. Substantial quantities of new scrap generated in the manufacture of GaAs-based devices were reprocessed.

**Import Sources (1992-95):** France, 46%; Russia, 19%; Germany, 17%; Hungary, 4%; and other, 14%.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Most favored nation (MFN) 12/31/96</b>	<b>Non-MFN<sup>2</sup> 12/31/96</b>
	Gallium metal	8112.91.1000	3.4% ad val.	25.0% ad val.
	Gallium arsenide wafers, undoped	2851.00.0010	2.8% ad val.	25.0% ad val.
	Gallium arsenide wafers, doped	3818.00.0010	Free	25.0% ad val.

**Depletion Allowance:** Not applicable.

**Government Stockpile:** None.

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**Events, Trends, and Issues:** The largest gallium recovery facility in the world (50,000 kilograms per year, located in Australia) reopened at the beginning of 1996 because of increased gallium demand. Rising demand for gallium in Japan and the United States during the past 3 years led to the release of inventories from Russia and Kazakstan; however, this was lower purity material and required additional purification to meet most consumer standards. As a result of the short supplies of high-purity gallium, consumers reported significant price increases in 1996. In Japan, gallium prices by mid-1996 were reported to be 30% higher than at the beginning of the year. New scrap, primarily generated during the production of GaAs, has provided an increasing share of world gallium supply.

Work continued to improve the qualities of GaAs and to improve yields. One firm, as part of the Government-sponsored title III program, produced longer single-crystal 100-millimeter boules and demonstrated the ability to produce 150-millimeter GaAs boules. These types of advancements have the potential to reduce the cost of GaAs components, and thus, increase their market share. In addition, work continued throughout the world to develop blue laser diodes and light-emitting diodes, based on gallium nitride.

**World Production, Reserves, and Reserve Base:** Data on world production of primary gallium were unavailable because data on the output of the few producers were considered to be proprietary. However, in 1996, world primary production was estimated to be about 63,000 kilograms, with Australia, Russia, Japan, and Kazakstan as the largest producers. Countries with smaller output were China, Hungary, and Slovakia. Refined gallium production was estimated to be about 70,000 kilograms. France was the largest producer of refined gallium, using as feed material crude gallium produced in Australia. Germany and Japan were the other large gallium refining countries.

Gallium occurs in very small concentrations in many rocks and ores of other metals. Most gallium was produced as a byproduct of treating bauxite, and the remainder was produced from zinc-processing residues. Significant reserves of gallium also occur in oxide minerals derived from surficial weathering of zinc-lead-copper ores. Only part of the gallium present in bauxite and zinc ores was recoverable, and the factors controlling the recovery were proprietary. Therefore, a meaningful estimate of current reserves could not be made. The world bauxite reserve base is so large that much of it will not be mined for many decades; hence, most of the gallium in the bauxite reserve base can be considered to have only long-term availability.

**World Resources:** Assuming that the average content of gallium in bauxite is 50 parts per million (ppm), U.S. bauxite resources, which are mainly subeconomic deposits, contain approximately 15 million kilograms of gallium. About 2 million kilograms of this metal are present in the bauxite deposits in Arkansas. Some domestic zinc ores contain as much as 50 ppm gallium and, as such, could be a significant resource. World resources of gallium in bauxite are estimated to exceed 1 billion kilograms, and a considerable quantity could be present in world zinc reserves. The foregoing estimates apply to total gallium content; only a small percentage of this metal in bauxite and zinc ores is economically recoverable.

**Substitutes:** Liquid crystals made from organic compounds are used in visual displays as substitutes for light-emitting diodes. Indium phosphide components can be substituted for GaAs-based infrared laser diodes, and GaAs competes with helium-neon lasers in visible laser diode applications. Silicon is the principal competitor for GaAs in solar cell applications. Because of their enhanced properties, GaAs-based integrated circuits are used in place of silicon in many defense-related applications, and there are no effective substitutes for GaAs in these applications.

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

<sup>1</sup>Defined as imports - exports + adjustments for Government and industry stock changes.

<sup>2</sup>See Appendix B.