GALLIUM

(Data in kilograms of gallium content, unless noted)

Domestic Production and Use: No domestic primary gallium recovery was reported in 1995. 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 $3.5 million. Gallium arsenide (GaAs) components represented about 95% of domestic gallium consumption. About 65% 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 33% of gallium demand, and the remainder 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.

Salient Statistics—United States:	**1991**	**1992**	**1993**	**1994**	**1995[e]**
Production, primary[e]	—	—	—	—	—
Imports for consumption	11,300	8,480	15,600	16,900	15,500
Exports	NA	NA	NA	NA	NA
Consumption: Reported	11,200	10,600	11,300	15,500	15,000
Consumption: Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure	525	425	400	395	425
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery[e]	20	20	20	20	20
Net import reliance[1] 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 (1991-94): France, 41%; Germany, 26%; Russia, 13%; United Kingdom, 4%; and other, 16%.

Tariff: Item	**Number**	**Most favored nation (MFN) 12/31/95**	**Non-MFN[2] 12/31/95**
Gallium metal	8112.91.1000	3.7% 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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<u>Events, Trends, and Issues</u>: One area in which intense research is being conducted is in the production of laser diodes and LED's that emit blue light. Researchers in the United States and Japan are committing significant resources toward producing gallium nitride with blue light-emitting properties. As an example, the Advanced Projects Research Agency awarded a $3.6 million contract to a consortium of private companies to develop gallium nitride technology. Blue LED's are useful because, when combined with green and red LED's, they enable the production of full-color displays. Applications for blue laser diodes include high-capacity optical disk drives, higher quality facsimile machines, submicron semiconductor device manufacturing, and medical applications.

As one step to developing high-capacity optical switches for information processing, U.S. researchers demonstrated a practical method for integrating high-performance, GaAs-based optoelectronics with high-density silicon-based circuitry on a single semiconductor chip. This type of component can be used for processing optical signals, such as infrared light that travels along fiber optic lines, electronically.

GaAs technology, originally developed for military applications, has continued to be adapted for commercial uses. Night-vision image intensifiers, based on GaAs, have evolved from solely military uses to widespread applications in security, law enforcement, and industrial low-light monitoring. Recent advances in night-vision technology have produced modules that were specifically designed for video cameras, allowing low- and no-light video recording capabilities for professional photographers and videographers. In addition, defense specifications are becoming more flexible, allowing adaptation of commercial off-the-shelf equipment to military uses.

<u>World Production, Reserves, and Reserve Base</u>: 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 1995, world primary production was estimated to be about 35,000 kilograms, with Germany, Russia, and Japan as the largest producers. Countries with smaller output were China, Hungary, Kazakstan, and Slovakia. Refined gallium production was estimated to be about 60,000 kilograms. France was the largest producer of refined gallium, using as feed material crude gallium produced in Australia that had been stockpiled since 1990. 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 residues from zinc processing. 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.

<u>World Resources</u>: 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.

<u>Substitutes</u>: 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.

[e]Estimated. NA Not available.

[1]Defined as imports - exports + adjustments for Government and industry stock changes.

[2]See Appendix B.