GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

Domestic Production and Use: No domestic primary gallium recovery was reported in 2007. One company in Utah recovered and refined gallium from scrap and impure gallium metal, and one company in Oklahoma refined gallium from impure metal. Imports of gallium, which supplied most of U.S. gallium consumption, were valued at about $11 million. Gallium arsenide (GaAs) and gallium nitride (GaN) electronic components represented about 98% of domestic gallium consumption. About 66% of the gallium consumed was used in integrated circuits (ICs). Optoelectronic devices, which include light-emitting diodes (LEDs), laser diodes, photodetectors, and solar cells, represented 20% of gallium demand. The remaining 14% was used in research and development, specialty alloys, and other applications. Optoelectronic devices were used in areas such as aerospace, consumer goods, industrial equipment, medical equipment, and telecommunications. ICs were used in defense applications, high-performance computers, and telecommunications.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, primary	—	—	—	—	—
Imports for consumption	14,300	19,400	15,800	26,900	31,700
Exports	NA	NA	NA	NA	NA
Consumption:					
Reported	20,100	21,500	18,700	20,300	22,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure[1]	411	550	538	443	460
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery, number[e]	20	20	20	20	20
Net import reliance[2] as a percentage of reported consumption[e]	99	99	99	99	99

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

Import Sources (2003-06): China, 23%; Ukraine, 17%; Japan, 16%; Hungary, 10%; and other, 34%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Gallium arsenide wafers, undoped	2853.00.0010	2.8% ad val.
Gallium arsenide wafers, doped	3818.00.0010	Free.
Gallium metal	8112.92.1000	3.0% ad val.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: Imports of gallium and GaAs wafers continued to supply almost all U.S. demand for gallium. Gallium metal imports were higher than those in 2006, but the estimated consumption did not increase significantly. This was because of some imports, particularly those from China and Germany, that were imported into the United States and then re-exported. After the gallium recycler-refiner in Utah and a gallium recycler in the United Kingdom jointly purchased the gallium production facility in Stade, Germany, in 2006, gallium that used to be refined in France was refined in China and the United States. The refinery in France, which was owned by the previous owner of the Stade facility, was closed.

A United States firm that manufactured GaAs substrates in China entered into an agreement with the Utah gallium recycler-refiner to supply 1,000 kilograms per month of 99.99999%-pure gallium to its China subsidiary beginning in July 2007. The 18-month agreement was estimated to be worth $7.3 million. The GaAs manufacturing firm also had majority ownership in a gallium production facility and a gallium refining facility in China. Presumably, gallium from the production facility would be refined in Utah and returned to China.

Prices for low-grade (99.99%-pure) gallium increased in the first half of 2007 from $300 to $350 per kilogram at the beginning of the year to about $500 per kilogram by midyear. Producers in China claimed that there was a shortage of supply, which was the principal reason for the increase in prices. Some were offering gallium at prices as high as $800 per kilogram, but little business was completed at this price level.

Prepared by **Deborah A. Kramer [(703) 648-7719, dkramer@usgs.gov, fax: (703) 648-7975]**

GALLIUM

The Canada-based firm that was attempting to develop a property in Humboldt County, NV, continued drilling at the property in 2007. Combining analytical results from new and previous drilling, the company believed that it developed a gallium mineralization model that was sufficient to identify additional higher grade exploration targets on the property. The company planned to begin geochemical surveys in September 2007.

After several years in which fabrication capacity has far exceeded market demand, global supply and demand of GaAs-base ICs returned to balance. Global consumption for GaAs ICs rose sharply to about 75% of total available capacity in 2006, from only 50% in 2005. Global capacity was estimated to be about 800,000 6-inch GaAs wafer equivalents. GaAs was expected to continue to be the dominant technology in cell phone handsets, the leading market for GaAs-base radio-frequency components, through 2012, according to market analysts. Overall, analysts estimated that the market for GaAs components exceeded $3 billion in 2006, and they predicted a compound average annual growth rate of 7% through 2010. In some applications, however, such as automotive radar and fiber optics applications, GaAs components were expected to face competition from silicon-germanium and silicon components.

Companies continued to try to improve the quality of GaN by improving growth and fabrication techniques. In addition to improvements in traditional substrate materials, such as sapphire and silicon carbide, companies are developing GaN grown on diamond and glass substrates. Firms also are trying to improve bulk GaN growth methods (similar to that used to produce GaAs crystals).

World Production, Reserves, and Reserve Base:[3] Data on world production of primary gallium are unavailable because data on the output of the few producers are considered to be proprietary. However, in 2007, world primary production was estimated to be about 80 metric tons, about the same as that in 2006. China, Germany, Japan, and Ukraine were the leading producers; countries with smaller output were Hungary, Kazakhstan, Russia, and Slovakia. Refined gallium production was estimated to be about 103 metric tons; this figure includes some scrap refining. China, Japan, and the United States were the principal producers of refined gallium. Gallium was recycled from new scrap in Germany, Japan, the United Kingdom, and the United States. World primary gallium production capacity in 2007 was estimated to be 184 metric tons; refinery capacity, 167 tons; and recycling capacity, 78 tons.

Gallium occurs in very small concentrations in ores of other metals. Most gallium is produced as a byproduct of treating bauxite, and the remainder is produced from zinc-processing residues. Only part of the gallium present in bauxite and zinc ores is recoverable, and the factors controlling the recovery are proprietary. Therefore, an estimate of current reserves that is comparable to the definition of reserves of other minerals cannot 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 cannot be considered to be available in the short term.

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 is 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 LEDs. Researchers also are working to develop organic-base LEDs that may compete with GaAs in the future. Indium phosphide components can be substituted for GaAs-base infrared laser diodes in some specific-wavelength applications, and GaAs competes with helium-neon lasers in visible laser diode applications. Silicon is the principal competitor for GaAs in solar cell applications. GaAs-base ICs are used in many defense-related applications because of their unique properties, and there are no effective substitutes for GaAs in these applications. GaAs in heterojunction bipolar transistors is being challenged in some applications by silicon-germanium.

[e]Estimated. NA Not available. — Zero.

[1]Estimated based on the average values of U.S. imports for 99.9999%- and 99.99999%-pure gallium.

[2]Defined as imports – exports + adjustments for Government and industry stock changes.

[3]See Appendix C for definitions.