GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

Domestic Production and Use: No domestic primary (crude, unrefined) gallium was recovered in 2013. Globally, primary gallium is recovered as a byproduct of processing bauxite and zinc ores. One company in Utah recovered and refined gallium from imported primary gallium metal and new scrap. Imports of gallium, which supplied most of U.S. gallium consumption, were valued at about $16 million. Gallium arsenide (GaAs) and gallium nitride (GaN) used in electronic components accounted for approximately 99% of domestic gallium consumption. About 68% of the gallium consumed was used in integrated circuits (ICs). Optoelectronic devices, which include laser diodes, light-emitting diodes (LEDs), photodetectors, and solar cells, accounted for nearly all of the remaining gallium consumption. Optoelectronic devices were used in aerospace applications, consumer goods, industrial equipment, medical equipment, and telecommunications equipment. Uses of ICs included defense applications, high-performance computers, and telecommunications equipment.

Salient Statistics—United States:	2009	2010	2011	2012	2013[e]
Production, primary	—	—	—	—	—
Imports for consumption	35,900	59,200	85,700	58,200	31,000
Exports	NA	NA	NA	NA	NA
Consumption, reported	24,900	33,500	35,300	34,400	34,000
Price, yearend, dollars per kilogram[1]	449	600	688	529	511
Stocks, consumer, yearend	4,100	4,970	6,850	6,220	4,700
Employment, refinery, number	20	20	20	20	20
Net import reliance[2] as a percentage of reported consumption	99	99	99	99	99

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

Import Sources (2009–12): Germany, 34%; United Kingdom, 26%; China, 21%; Canada, 6%; and other, 13%.

Tariff: Item	Number	Normal Trade Relations 12–31–13
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 prices remained unchanged throughout 2013. The price for low-grade (99.99%-pure) gallium in Asia averaged $280 per kilogram from January through September. Prices had declined rapidly from mid-2011 to yearend 2012 owing to significant increases in gallium production and declining demand from LED producers. Chinese gallium production capacity expanded tremendously in 2011 and 2012 on the expectation of a strong LED-based backlighting market, which failed to materialize.

Global demand for GaAs- and GaN-based products increased in 2013. GaAs demand, while still driven mainly by cellular telephones and other high-speed wireless applications, increased owing to growth of feature-rich, application-intensive, third- and fourth-generation “smartphones,” which employ up to 10 times the amount of GaAs as standard cellular handsets. Smartphones accounted for approximately 40% of all cellular telephone sales in 2013. Owing to the rise of GaAs content in smartphones and increased penetration of GaAs-based LEDs in general lighting and automotive applications, the GaAs substrate market was forecast to increase at an average annual growth rate of nearly 11%, increasing to $650 million by 2017 from $390 million in 2012. The GaAs device market was anticipated to increase at an average rate of 3.2% per year to $6.1 billion by 2016 from $5.2 billion in 2011.

Owing to the large power-handling capabilities, high-switching frequencies, and higher voltage capabilities of GaN technology, GaN-based products, which historically have been used in defense and military applications, have begun to gain acceptance in cable television transmission, commercial wireless infrastructure, power electronics, and satellite markets. The GaN power device market was forecast to increase at an average annual growth rate of nearly 29%, to reach $178 million in 2015.

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During the last several years, significant expansion of worldwide LED manufacturing capacity took place, much of it owing to government instituted incentives to increase LED production, and LED prices declined. With the rate of adoption of LEDs in television backlighting slowing, the LED industry was expected to focus on general lighting applications for the rest of the decade. The highest growth rate in the lighting industry was forecast to be in LED-based tubes that could replace fluorescent tubes used in commercial applications, as well as LED-based street lights and LED luminaires of varying sizes. More than 100 billion GaN LEDs were expected to ship in 2013, more than triple the number shipped in 2009.

Sustained high energy prices continued to spark interest in solar energy in 2013. Scientists in Switzerland achieved a record 20.4% efficiency for a copper-indium-gallium diselenide (CIGS) thin-film solar cell on a flexible polymer substrate. CIGS technology, however, has been slow to enter the commercial market owing to a complicated manufacturing process that has kept the cost of production of CIGS panels high. Decreased prices of silicon-based solar cells led to lower consumption of the more expensive CIGS cells. A large oversupply of CIGS modules caused prices to decline by 20% in 2011 and remain low throughout 2012 and 2013.

World Production and Reserves:[3] In 2013, world primary gallium production was estimated to be 280 metric tons, 27% less than the 2012 world primary production of 383 tons. Reports and trade data indicated that many primary gallium producers reduced output owing to the large surplus of primary gallium produced in 2012. China, Germany, Kazakhstan, and Ukraine were the leading producers; countries with lesser output were Hungary, Japan, the Republic of Korea, and Russia. Refined gallium production in 2013 was estimated to be about 200 tons, about 30% less than primary production. China, Japan, the United Kingdom, and the United States were the principal producers of refined gallium. Gallium was recycled from new scrap in Canada, Germany, Japan, the United Kingdom, and the United States. World primary gallium production capacity in 2013 was estimated to be 470 tons; refinery capacity, 300 tons; and secondary capacity, 200 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 comparable to the definition of reserves of other minerals cannot be made.

World Resources: The average gallium content of bauxite is 50 parts per million (ppm). U.S. bauxite deposits consist mainly of subeconomic resources that are not generally suitable for alumina production owing to their high silica content. Recovery of gallium from these deposits is therefore unlikely. Some domestic zinc ores contain as much as 50 ppm gallium and, as such, could be a significant resource. Gallium contained in world resources of bauxite is estimated to exceed 1 million metric tons, and a considerable quantity could be contained in world zinc resources. However, only a small percentage of the gallium in bauxite and zinc resources is potentially recoverable.

Substitutes: Liquid crystals made from organic compounds are used in visual displays as substitutes for LEDs. Researchers also are working to develop organic-based LEDs that may compete with GaAs in the future. Indium phosphide components can be substituted for GaAs-based 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 with GaAs in solar-cell applications. GaAs-based ICs are used in many defense-related applications because of their unique properties, and no effective substitutes exist 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 resource/reserve definitions and information concerning data sources.