GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

Domestic Production and Use: No domestic primary (crude, unrefined) gallium has been recovered since 1987. 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 $21 million. Gallium arsenide (GaAs) and gallium nitride (GaN) wafers used in integrated circuits (ICs) and optoelectronic devices accounted for approximately 80% of domestic gallium consumption. Trimethyl gallium and triethyl gallium, metalorganic sources of gallium used in the epitaxial layering process for the production of light-emitting diodes (LEDs), accounted for most of the remainder. About 74% of the gallium consumed was used in ICs. Optoelectronic devices, which include laser 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:	2010	2011	2012	2013	2014[e]
Production, primary	—	—	—	—	—
Imports for consumption	59,200	85,700	58,200	35,400	57,000
Exports	NA	NA	NA	NA	NA
Consumption, reported	33,500	35,300	34,400	37,800	40,000
Price, yearend, dollars per kilogram[1]	600	688	529	502	362
Stocks, consumer, yearend	4,970	6,850	6,220	5,470	4,800
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 to recover high-purity gallium at one facility in Utah.

Import Sources (2010–13): Germany, 36%; United Kingdom, 24%; China, 23%; Ukraine, 6%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12–31–14
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 decreased throughout 2014, continuing the more than 2-year decline, as significant increases in China's low-grade (99.99%-pure) gallium production continued to exceed increases in worldwide consumption. In January, the price for low-grade gallium in Asia averaged $270 per kilogram. By September, the price had decreased to $240 per kilogram. China's low-grade gallium production capacity has expanded tremendously in recent years, from 140 metric tons per year in 2010 to approximately 550 metric tons per year in 2014 on the expectations of increases in LED-based backlighting and general lighting demand. China accounted for 80% of worldwide low-grade gallium capacity.

Global demand for GaAs- and GaN-based products increased in 2014. GaAs device demand increased by about 6% to $6.25 billion owing to a growing wireless infrastructure in Asia, and 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. Worldwide sales of smartphones exceeded those of standard cellular telephones for the first time in 2013. In 2014, smartphones were estimated to account for 65% of all worldwide cellular telephone sales.

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 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 production costs and prices declined. With the rate of adoption of LEDs in television backlighting slowing, however, 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 to replace fluorescent tubes used in commercial applications, as well as LED-based street lights and LED luminaires of varying sizes. Global shipments of GaN LEDs increased about 7% in 2014, to reach about $13 billion.

In 2014, scientists in Germany achieved a record 21.7% efficiency for a copper-indium-gallium diselenide (CIGS) thin-film solar cell. However, owing to a complicated manufacturing process that has kept the cost of production high, and declining prices for silicon-based solar cells, consumption of CIGS cells have declined. A large oversupply of CIGS modules caused prices to decline by 20% in 2011 and to remain at the lower level into 2014.

World Production and Reserves:[3] In 2014, world primary gallium production was estimated to be 440 metric tons—26% more than the revised 2013 world primary production of 350 metric tons. By yearend, some primary gallium producers may have reduced output owing to a large surplus of primary gallium. China, Germany, Japan, and Ukraine were the leading producers; countries with lesser output were Hungary, the Republic of Korea, and Russia. Kazakhstan, which had been a leading producer in 2012, did not produce any primary gallium in 2013, and it was uncertain if it had production in 2014. Refined gallium production in 2014 was estimated to be about 170 metric tons. China, Japan, the United Kingdom, the United States, and possibly Slovakia 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 2014 was estimated to be 680 metric tons; refinery capacity, 230 metric tons; and secondary capacity, 200 metric 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 could be a significant resource, although no gallium is currently recovered from domestic ore. 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. Silicon-based complementary metal-oxide semiconductor (CMOS) power amplifiers compete with GaAs power amplifiers in mid-tier 3G cellular handsets. Indium phosphide components can be substituted for GaAs-based infrared laser diodes in some specific-wavelength applications, and helium-neon lasers compete with GaAs 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.