GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

Domestic Production and Use: No domestic primary gallium recovery was reported in 2010. 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 $35 million. Gallium arsenide (GaAs) and gallium nitride (GaN) electronic components represented about 99% of domestic gallium consumption. About 64% of the gallium consumed was used in integrated circuits (ICs). Optoelectronic devices, which include laser diodes, light-emitting diodes (LEDs), photodetectors, and solar cells, represented 35% of gallium demand. The remaining 1% 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:	**2006**	**2007**	**2008**	**2009**	**2010[e]**
Production, primary	—	—	—	—	—
Imports for consumption	26,900	37,100	41,100	35,900	59,000
Exports	NA	NA	NA	NA	NA
Consumption, reported	20,300	25,100	28,700	24,900	40,000
Price, yearend, dollars per kilogram, 99.99999%-pure[1]	443	530	579	449	670
Stocks, consumer, yearend	1,890	6,010	3,820	4,100	2,000
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-base devices were reprocessed.

Import Sources (2006–09): Germany, 26%; Canada, 23%; China, 17%; Ukraine, 12%; and other, 22%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-10**
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 increased sharply throughout the second and third quarters of 2010 as end users restocked inventories depleted since the beginning of the global economic slowdown. Prices for low-grade (99.99%-pure) gallium increased in Asia and Europe in the first three quarters of 2010, from between $340 and $450 per kilogram at the beginning of the year to between $610 and $650 per kilogram by early October.

Market conditions improved significantly for GaAs- and GaN-based products in 2010. GaAs demand, while still being driven mainly by cellular handsets and other high-speed wireless applications, increased owing to rapid growth of feature-rich, application-intensive, third- and fourth-generation “smartphones,” which employ considerably higher GaAs content than standard cellular handsets. Smartphones were estimated to account for 19% of all handset sales in 2010. Analysts estimated the smartphone market’s sales volume will grow at an annual growth rate of 15% to 25% for the next several years.

The rapidly growing high-brightness LED industry was also a significant driver for GaAs- and GaN-based technologies. The backlighting of computer notebook screens, flat-screen computer monitors, and flat-screen televisions was the driving force for high-brightness LED consumption in 2010. The market share of LED-backlit computer notebooks was estimated by one analyst to have increased to 89% in 2010 from 46% in 2009, while LED-backlit computer monitors increased to 12% in 2010 from 2% in 2009, and LED-backlit flat-screen televisions increased to 22% in 2010 from 3% in 2009.The market for high-brightness LEDs reached $5.3 billion in 2009 and was expected to increase to $8.2 billion in 2010.

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In response to the unprecedented demand for high-brightness LEDs, several trimethylgallium (TMG) producers announced plans to expand their TMG capacities. TMGs are metalorganic precursors used in the production of LEDs. Two plants in the United States and one plant in the United Kingdom were expected to expand their TMG capacities to address short-term demand as quickly as possible, while a new plant was to be built in South Korea to create capacity for long-term demand.

As part of the American Recovery and Reinvestment Act, the U.S. Department of Energy (DOE) provided $13.4 million in funding to four GaN-based research projects to accelerate development in power electronics. The projects, funded through DOE's Advanced Research Projects Agency-Energy, focus on accelerating innovation in green technology while increasing United States' competitiveness in power electronics, grid-scale energy storage, and building efficiency.

Researchers at the University of Illinois announced the development of an efficient, lower cost method of manufacturing photovoltaic GaAs compound semiconductors that also allows versatility in the types of devices into which they could be incorporated. The manufacturing method allows creation of bulk quantities of flexible GaAs-based solar cells that can be incorporated onto surface areas much larger than conventional solar panels.

A German company achieved a record 20.3% efficiency for its copper-indium-gallium diselenide (CIGS) thin-film solar cell. The company's CIGS material features a flexible substrate that allows it to be lightweight, flexible, and durable, unlike traditional solar panels that tend to be heavy, rigid, and fragile. The Fraunhofer Institute for Solar Energy Systems in Freiburg, Germany, confirmed the new results.

World Production and Reserves:[3] In 2010, world primary production was estimated to be 106 metric tons, 34% greater than the revised 2009 world primary production of 79 tons. China, Germany, Kazakhstan, and Ukraine were the leading producers; countries with lesser output were Hungary, Japan, Russia, and Slovakia. Refined gallium production was estimated to be about 161 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 Canada, Germany, Japan, the United Kingdom, and the United States. World primary gallium production capacity in 2010 was estimated to be 184 tons; refinery capacity, 177 tons; and recycling capacity, 141 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. The world bauxite reserves are so large that much of them will not be mined for many decades; hence, most of the gallium in the bauxite reserves 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 deposits, which are mainly subeconomic resources, 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-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 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 resource/reserve definitions and information concerning data sources.