GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

Domestic Production and Use: No domestic primary gallium recovery was reported in 2009. 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 $14 million. Gallium arsenide (GaAs) and gallium nitride (GaN) electronic components represented about 98% of domestic gallium consumption. About 67% 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 31% of gallium demand. The remaining 2% 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:	2005	2006	2007	2008	2009[e]
Production, primary	—	—	—	—	—
Imports for consumption	15,800	26,900	37,100	41,100	29,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent[1]	18,700	20,300	25,100	28,700	20,000
Price, yearend, dollars per kilogram, 99.99999%-pure[2]	538	443	530	579	480
Stocks, consumer, yearend	1,800	1,890	6,010	3,820	4,000
Employment, refinery, number	20	20	20	20	20
Net import reliance[3] 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 (2005-08): Germany, 24%; Canada, 20%; China, 16%; Ukraine, 12%; and other, 28%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
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. The global economic slowdown weakened demand for gallium in 2009 and allowed existing stocks of unsold gallium to exert downward pressure on prices. Prices for low-grade (99.99%-pure) gallium decreased in Asia and Europe in the first half of 2009, from between $520 and $580 per kilogram at the beginning of the year to between $360 and $450 per kilogram by midyear. Prices in the United States decreased to between $450 and $500 per kilogram.

Several records for solar cell efficiency were achieved in 2009. One company set a world record for terrestrial concentrator solar cell efficiency with a photovoltaic device that converts greater than 41% of the light that hits it into electricity. The solar cell incorporated improvements in wafer processing that raised the cell's overall efficiency. Additionally, another company achieved a record 15.45% efficiency for its copper indium gallium diselenide (CIGS) thin film solar cell. The company's CIGS material utilizes a flexible substrate that allows it to be lightweight, flexible, and durable, unlike traditional solar panels which tend to be heavy, rigid, and fragile. Both solar cell efficiency records were verified by the U.S. Department of Energy's National Renewable Energy Laboratory.

Scientists at Massachusetts Institute of Technology (MIT) successfully integrated GaN with silicon to create a hybrid microchip that is expected to be smaller, faster, and more efficient than current silicon-based microprocessors. The MIT scientists anticipate the new integration process will enable circuit and system designers to uncompromisingly choose the best semiconductor material for each device in the microchip.

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GALLIUM

A Canadian-based firm that previously had completed an independent gallium resource estimate on a property in Humboldt County, NV, announced at the end of 2008 that it had suspended preparation of a preliminary feasibility study owing to turmoil in the global economy and the uncertainty of near-term gallium prices.

Market conditions deteriorated for GaAs-based products in 2009. GaAs demand, while still being driven mainly by high-speed, feature-rich, third-generation, cellular handsets and other high-speed wireless applications, was expected to decrease by 5% in 2009. Analysts estimated that the GaAs market will generate revenues of $3.5 billion in 2009.

Analysts estimated that the high-brightness LED market would decrease by 3.7% in 2009 as a result of the global economic downturn that began late in 2008. However, not all LED markets were being affected equally. Mature LED market segments including automotive lighting, mobile phones, and outdoor video screens were decreasing, while emerging LED market segments, such as backlights for liquid crystal displays in televisions and notebook computers, were still showing growth. The market for high-brightness LEDs reached $5.1 billion in 2008 and was expected to decrease to $4.9 billion in 2009.

World Production and Reserves:[4] In 2009, world primary production was estimated to be 78 metric tons, 30% lower than the revised 2008 world primary production of 111 tons. China, Germany, Kazakhstan, and Ukraine were the leading producers; countries with smaller output were Hungary, Japan, Russia, and Slovakia. Refined gallium production was estimated to be about 118 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 2009 was estimated to be 184 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 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 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-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]Reported consumption was utilized for apparent consumption for the years 1970 to the most recent.
[2]Estimated based on the average values of U.S. imports for 99.9999%- and 99.99999%-pure gallium.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.