

## GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

**Domestic Production and Use:** No domestic primary gallium recovery was reported in 2008. 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 \$23 million. Gallium arsenide (GaAs) and gallium nitride (GaN) electronic components represented about 98% of domestic gallium consumption. About 65% 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 29% of gallium demand. The remaining 6% 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.

<b>Salient Statistics—United States:</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008<sup>e</sup></b>
Production, primary	—	—	—	—	—
Imports for consumption	19,400	15,800	26,900	37,100	48,400
Exports	NA	NA	NA	NA	NA
Consumption:					
Reported	21,500	18,700	20,300	25,100	30,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure <sup>1</sup>	550	538	443	530	560
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery, numbers	20	20	20	20	20
Net import reliance <sup>2</sup> as a percentage of reported consumptione	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 (2004-07):** China, 17%; Ukraine, 17%; Germany, 16%; Canada, 14%; and other, 36%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12-31-08</b>
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 and were higher than those in 2007. Prices for low-grade (99.99%-pure) gallium decreased in Asia and Europe in the first half of 2008, from \$550 to \$600 per kilogram at the beginning of the year to about \$475 to \$525 per kilogram by midyear. Some producers in China claimed that prices are lower owing to a seasonal slowdown. Prices in the United States remained stable at \$550 to \$600 per kilogram.

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The U.S. Department of Energy's National Renewable Energy Laboratory (NREL) set a world record in solar cell efficiency with a photovoltaic device that converts 40.8% percent of the light that hits it into electricity. The solar cell uses compositions of gallium indium phosphide and gallium indium arsenide to split the solar spectrum into three equal parts that are absorbed by each of the cell's three junctions for higher potential efficiencies.

A Canadian-based firm completed drilling on its property in Humboldt County, NV. Based on an updated, independent gallium resource estimate, indicated resources were 714 metric tons of gallium and inferred resources were 335 tons. The firm plans to collect a bulk sample for metallurgical testing in preparation for a prefeasibility study.

Market conditions remained strong for GaAs-based products in 2008. Demand was driven mainly by high-speed, feature-rich, third-generation, cellular handsets and other high-speed wireless applications, which require greater numbers of GaAs components per unit than previously used. Analysts estimated that the market for GaAs components exceeded \$3.6 billion in 2007, and exhibited year-on-year growth of 17%.

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.

Analysts estimated that the LED market would increase by 12% in 2008 as a result of product expansion outside of the mobile phone market. New applications included LED backlighting for liquid crystal displays, notebook PC backlighting, digital cameras, DVD players, and automotive lighting. The market for packaged LEDs reached \$4.6 billion in 2007.

**World Production, Reserves, and Reserve Base:**<sup>3</sup> In 2008, world primary production was estimated to be about 95 metric tons, about 19% higher than that in 2007. 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 135 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 2008 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-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.

<sup>0</sup>Estimated. NA Not available. — Zero.

<sup>1</sup>Estimated based on the average values of U.S. imports for 99.9999%- and 99.99999%-pure gallium.

<sup>2</sup>Defined as imports – exports + adjustments for Government and industry stock changes.

<sup>3</sup>[See Appendix C for definitions.](#)