GALLIUM

(Data in kilograms of contained gallium unless otherwise noted)

Domestic Production and Use: No domestic primary (low-purity, unrefined) gallium has been recovered since 1987. Globally, primary gallium is recovered as a byproduct of processing bauxite and zinc ores. One company in New York recovered and refined high-purity gallium from imported primary low-purity gallium metal and new scrap. Imports of gallium metal and gallium arsenide (GaAs) wafers were valued at about $5 million and $220 million, respectively. GaAs was used to manufacture compound semiconductor wafers used in integrated circuits (ICs) and optoelectronic devices, which include laser diodes, light-emitting diodes (LEDs), photodetectors, and solar cells. Gallium nitride (GaN) principally was used to manufacture optoelectronic devices. ICs accounted for 74% of domestic gallium consumption, optoelectronic devices accounted for 25%, and research and development accounted for 1%. About 77% of the gallium consumed in the United States was in GaAs, GaN, and gallium phosphide wafers. Gallium metal, triethyl gallium, and trimethyl gallium, used in the epitaxial layering process to fabricate epiwafers for the production of ICs and LEDs, accounted for most of the remainder. 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:	**2018**	**2019**	**2020**	**2021**	**2022[e]**
Production, primary	—	—	—	—	—
Imports for consumption:					
Metal	32,000	5,740	4,430	8,890	12,000
Gallium arsenide wafers (gross weight)	444,000	272,000	178,000	306,000	550,000
Exports	NA	NA	NA	NA	NA
Consumption, reported	15,000	14,900	15,700	17,100	18,000
Price, average unit value of imports, dollars per kilogram:					
High-purity, refined[1]	508	573	596	625	640
Low-purity, primary[2]	185	153	163	254	420
Stocks, consumer, yearend	2,920	2,850	2,920	2,810	2,800
Net import reliance[3] as a percentage of reported consumption	100	100	100	100	100

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 New York.

Import Sources (2018–21): Metal: China, 53%; Germany and Japan, 13% each; Ukraine, 5%; and other, 16%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–22**
Gallium arsenide wafers, doped	3818.00.0010	Free.
Gallium metal	8112.92.1000	3% ad valorem.

Depletion Allowance: 14% (domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Imports of gallium metal, GaAs wafers, and GaN wafers continued to account for all U.S. consumption of gallium. In 2022, gallium metal imports increased by an estimated 34% from those in 2021 owing to increased imports from Canada, China, Slovakia, and the United Kingdom. Beginning in 2019, U.S. gallium metal imports decreased substantially from those in previous years because higher tariffs were placed on China's gallium exports to the United States.

Primary low-purity (99.99%-pure) gallium prices in China averaged $510 per kilogram in June 2022, an increase of 34% from $380 per kilogram in January. This followed a 36% increase in China's primary low-purity gallium in 2021, to $375 per kilogram in December from $275 per kilogram in January. The increases in China's gallium prices resulted from several issues. Environmental restrictions placed on Chinese bauxite production in 2019 compelled the country's alumina refineries to import bauxite with lower gallium content from abroad, which increased gallium extraction costs. When the economic impact of the global coronavirus disease 2019 (COVID-19) pandemic reduced gallium demand in early to mid-2020, Chinese gallium producers slowed or shut down operations. Chinese gallium supply was scarce when gallium demand recovered in the second half of 2020 owing increasingly to gallium consumption in fifth-generation (5G) telecommunications networks and neodymium-iron-boron (NdFeB) magnets in China for electric vehicles. Gallium prices increased significantly in the last quarter of 2020, continuing through June 2022. By October, gallium prices in China decreased by 33% to $340 per kilogram owing to reduced demand for NdFeB magnets and an increase in China's primary low-purity gallium production capacity.

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China's primary low-purity gallium production capacity increased by 100,000 kilograms per year in 2022 to 750,000 kilograms per year. This latest increase followed a series of expansions from a capacity of 140,000 kilograms per year in 2010. China accounted for approximately 86% of worldwide primary low-purity gallium production capacity of an estimated 870,000 kilograms per year. China accounted for 98% of worldwide primary low-purity gallium production.

The remaining primary low-purity gallium producers outside of China most likely restricted output owing to China's dominant production capacity. These producers included Japan, the Republic of Korea, Russia, and Ukraine. Germany, Hungary, and Kazakhstan ceased primary production in 2016, 2015, and 2013, respectively. However, owing to the increase in gallium prices, Germany announced that it would eventually restart primary gallium production.

High-purity refined gallium production in 2022 was estimated to be about 290,000 kilograms, a 16% increase from the revised estimated figure of 250,000 kilograms in 2021. Canada, China, Japan, Slovakia, and the United States were the known principal producers of high-purity refined gallium. The United Kingdom ceased high-purity refined gallium production in 2018. Gallium was recovered from new scrap in Canada, China, Japan, Slovakia, and the United States. World high-purity refined gallium production capacity was an estimated 320,000 kilograms per year, and secondary high-purity gallium production capacity was an estimated 300,000 kilograms per year.

Beginning in 2002, Northrop Grumman has been awarded Defense Advanced Research Project Agency (DARPA) contracts by the U.S. Department of Defense to develop GaN Monolithic Microwave Integrated Circuits for military and commercial uses.

World Production and Reserves: Quantitative estimates of reserves were not available.

	Primary production		Production capacity
	2021	2022[e]	2022
United States	—	—	—
China	[4]423,000	540,000	750,000
Japan	3,000	3,000	[e]10,000
Korea, Republic of	2,000	2,000	[e]16,000
Russia	5,000	5,000	[e]10,000
Ukraine	1,000	1,000	[e]15,000
Other countries[5]	—	—	[e]73,000
World total (rounded)	434,000	550,000	[e]870,000

World Resources:[6] Gallium occurs in very small concentrations in ores of other metals. Most gallium is produced as a byproduct of processing bauxite, and the remainder is produced from zinc-processing residues. The average gallium content of bauxite is 50 parts per million. U.S. bauxite deposits consist mainly of subeconomic resources that are not generally suitable for alumina production owing to their high silica content. Some domestic zinc ores contain up to 50 parts per million gallium and could be a significant resource, although no gallium is currently recovered from domestic ores. Gallium contained in world resources of bauxite is estimated to exceed 1 million tons, and a considerable quantity could be contained in world zinc resources. However, less than 10% 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. Silicon-based complementary metal-oxide semiconductor power amplifiers compete with GaAs power amplifiers in midtier third-generation (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. In many defense-related applications, GaAs-based ICs are used because of their unique properties, and no effective substitutes exist for GaAs in these applications. In heterojunction bipolar transistors, GaAs is being replaced in some applications by silicon-germanium.

[e]Estimated. NA Not available. — Zero.

[1]Estimated based on the average unit values of U.S. imports for 99.999%- and 99.99999%-pure gallium

[2]Estimated based on the average unit values of U.S. imports for 99.99%-pure gallium.

[3]Defined as imports – exports. Excludes gallium arsenide wafers.

[4]Reported.

[5]Other countries thought to still have primary low-purity gallium production capacity include Germany, Hungary, and Kazakhstan.

[6]See Appendix C for resource and reserve definitions and information concerning data sources.