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 Utah 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 $3 million and $200 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 77% of domestic gallium consumption, optoelectronic devices accounted for 21%, and research and development accounted for 2%. About 81% of the gallium consumed in the United States was contained in GaAs, GaN, and gallium phosphide (GaP) 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:	**2017**	**2018**	**2019**	**2020**	**2021[e]**
Production, primary	—	—	—	—	—
Imports for consumption:					
Metal	20,200	32,000	5,740	4,460	10,600
Gallium arsenide wafers (gross weight)	803,000	444,000	272,000	178,000	270,000
Exports	NA	NA	NA	NA	NA
Consumption, reported	17,900	15,000	14,900	15,700	16,000
Price, imports, dollars per kilogram:					
High-purity, refined[1]	477	508	573	596	570
Low-purity, primary[2]	124	185	153	163	200
Stocks, consumer, yearend	2,840	2,920	2,850	2,920	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 Utah.

Import Sources (2017–20): Metal: China,[4] 53%; the United Kingdom, 11%; Germany, 9%; Ukraine, 7%; and other, 20%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–21**
Gallium arsenide wafers, doped	3818.00.0010	Free.
Gallium metal	8112.92.1000	3.0% ad valorem.

Depletion Allowance: 14% (domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Imports of gallium metal and GaAs wafers continued to account for all U.S. consumption of gallium. In 2021, gallium metal imports increased by an estimated 140% from those of 2020 owing to increased imports from Canada, Japan, and Singapore. Beginning in 2019, U.S. gallium metal imports decreased substantially from previous years when higher tariffs were placed on China's gallium exports to the United States.

Primary low-purity (99.99%-pure) gallium prices in China increased by an estimated 25% in 2021, to $345 per kilogram in October from approximately $275 per kilogram at yearend 2020. This followed a 96% increase in China's primary low-purity gallium prices in 2020, to $275 per kilogram in December from $140 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 global 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 resumed in the second half of 2020, and gallium prices increased significantly in the last quarter of 2020, continuing through 2021.

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China's primary low-purity gallium production capacity has been approximately 650,000 kilograms per year since 2020, following an expansion from 140,000 kilograms per year in 2010. China accounted for approximately 84% of worldwide low-purity gallium capacity.

The remaining primary low-purity gallium producers outside of China most likely restricted output owing to a large surplus of primary gallium that began in 2012. These producers included Japan, the Republic of Korea, and Russia. Germany and Kazakhstan ceased primary production in 2016 and 2013, respectively. However, owing to the increase in gallium prices in 2020 and 2021, Germany announced that it would restart primary gallium production by the end of 2021. Hungary and Ukraine were thought to have ceased primary production in 2015 and 2019, respectively. High-purity refined gallium production in 2021 was estimated to be about 225,000 kilograms, a 5% increase from that in 2020. 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, Germany, Japan, Slovakia, and the United States. World primary low-purity gallium production capacity in 2021 was estimated to be 774,000 kilograms per year; high-purity refined gallium production capacity, 325,000 kilograms per year; and secondary high-purity gallium production capacity, 273,000 kilograms per year.

World Production and Reserves:

	Primary production		Reserves[5]
	2020	2021[e]	
United States	—	—	Quantitative estimates of reserves are not available.
China	317,000	420,000	
Japan	3,000	3,000	
Korea, Republic of	2,000	2,000	
Russia	5,000	5,000	
World total (rounded)	327,000	430,000	

World Resources:[5] 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]Includes Hong Kong.

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