GALLIUM

(Data in kilograms of gallium content 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 $1 million and $150 million, respectively. GaAs was used to manufacture 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 72% of domestic gallium consumption, optoelectronic devices accounted for 25%, and research and development accounted for 3%. About 80% 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 LEDs and ICs, 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:	**2016**	**2017**	**2018**	**2019**	**2020[e]**
Production, primary	—	—	—	—	—
Imports for consumption:					
Metal	10,500	20,200	32,000	5,740	4,600
Gallium arsenide wafers (gross weight)	1,290,000	803,000	444,000	272,000	190,000
Exports	NA	NA	NA	NA	NA
Consumption, reported	18,100	17,900	15,000	14,900	15,000
Price, imports, dollars per kilogram:					
High-purity, refined[1]	690	477	508	570	570
Low-purity, primary[2]	125	124	185	150	170
Stocks, consumer, yearend	2,720	2,840	2,920	2,850	2,700
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 (2016–19): Metal: China,[4] 55%; the United Kingdom, 11%; Germany, 10%; and other, 24%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–20**
Gallium arsenide wafers, doped	3818.00.0010	Free.
Gallium metal	8112.92.1000	3.0% ad val.

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 2020, gallium metal imports decreased by an estimated 20% from those of 2019, most likely owing to higher import tariffs on gallium from China that began in 2019. This followed a 300% increase of gallium metal imports from China in 2018 before the tariffs were introduced. In 2019, gallium metal imports from China decreased by 97% from those of 2018.

Primary low-purity (99.99%-pure) gallium prices in China increased by an estimated 32% in 2020 owing mostly to reduced production in China. The price for primary low-purity gallium in China increased to $185 per kilogram in September 2020 from approximately $140 per kilogram at yearend 2019. China's primary low-purity gallium production capacity has been approximately 600,000 kilograms per year since 2016, following an expansion from 140,000 kilograms per year in 2010. China accounted for more than 80% 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. Hungary and Ukraine were thought to have ceased primary production in 2015 and 2019, respectively.

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High-purity refined gallium production in 2020 was estimated to be about 220,000 kilograms, a 5% increase from that of 2019. 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 2020 was estimated to be 724,000 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.

In 2019, the value of worldwide radio frequency (RF) GaAs device consumption decreased by 4% to $8.6 billion owing primarily to a decline in third- and fourth-generation (3G and 4G) “smartphone” shipments. In 2020, worldwide RF GaAs device consumption was expected to decrease by 4% from that of 2019 owing to the impacts of the COVID-19 pandemic and a United States–China trade dispute that resulted in higher ad valorem tariffs on imports from China. Global GaAs wafer consumption by volume was estimated to have increased by 14% in 2020, with an estimated 48%, 32%, and 20% of wafers used in LED, RF, and photonics applications, respectively. Countries within the Asia and the Pacific region dominated the GaAs wafer market.

Owing to their large power-handling capabilities, high-switching frequencies, and higher voltage capabilities, GaN-based products, which historically have been used in defense applications, are used in fifth-generation (5G) networks, cable television transmission, commercial wireless infrastructure, power electronics, and satellite markets. The value of the GaN RF device market was estimated to be $940 million in 2020, an increase of 22% from the revised $770 million in 2019. The global high-power LED market was estimated to be $14 billion in 2020, an increase of 5.3% from that in 2019.

World Production and Reserves:

	Primary production		Reserves[5]
	2019	2020[e]	
United States	—	—	Quantitative estimates of reserves are not available.
China	338,000	290,000	
Japan	3,000	3,000	
Korea, Republic of	2,000	3,000	
Russia	8,000	4,000	
Ukraine	—	—	
World total (rounded)	351,000	300,000	

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 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 values of U.S. imports for 99.9999%- and 99.99999%-pure gallium.

[2]Estimated based on the average 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.